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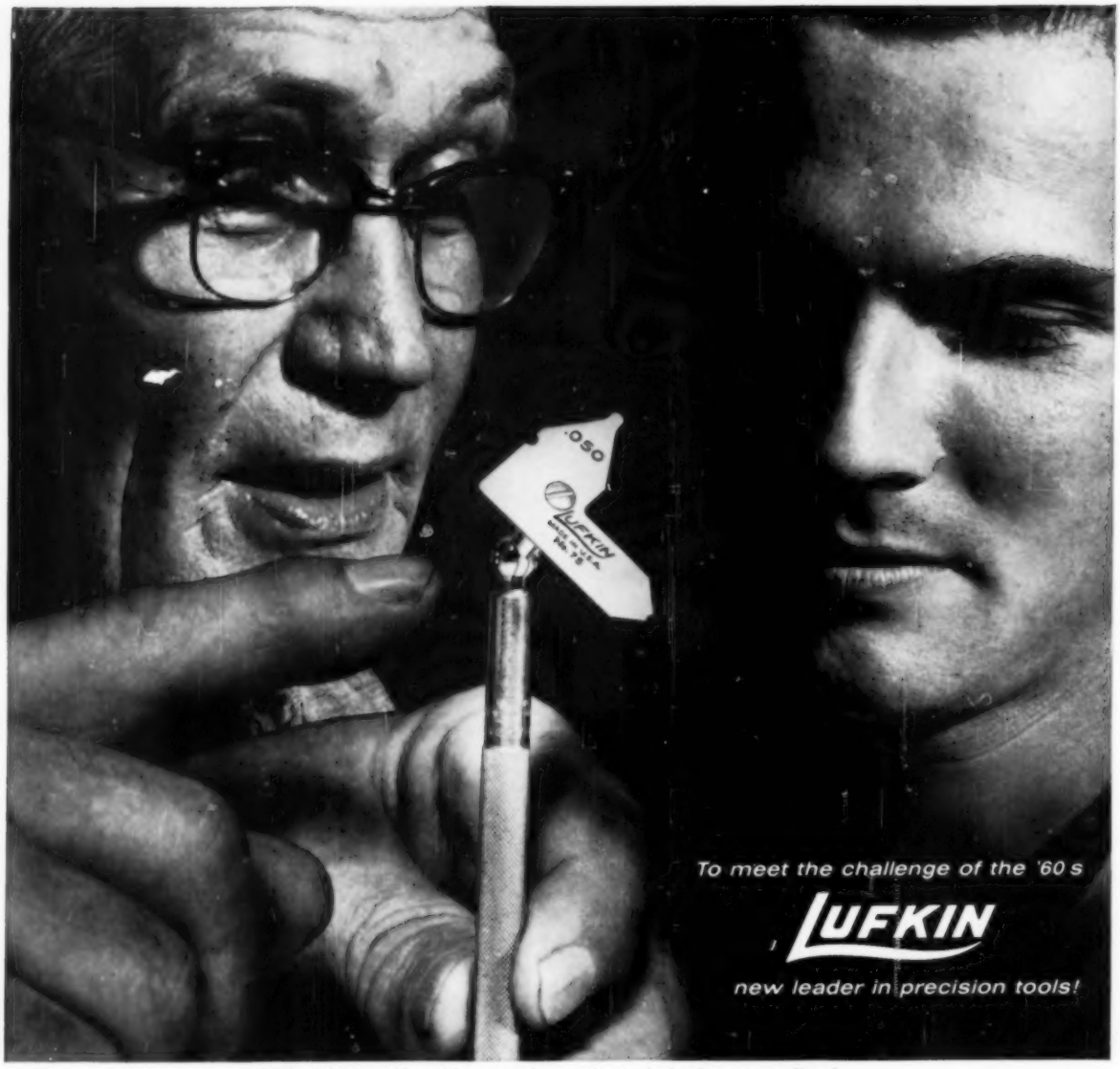
INDUSTRIAL QUALITY CONTROL

QUALITY through Scientific Methods

JOURNAL OF THE AMERICAN SOCIETY FOR QUALITY CONTROL



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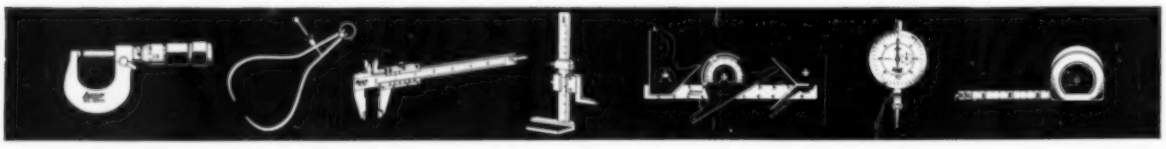

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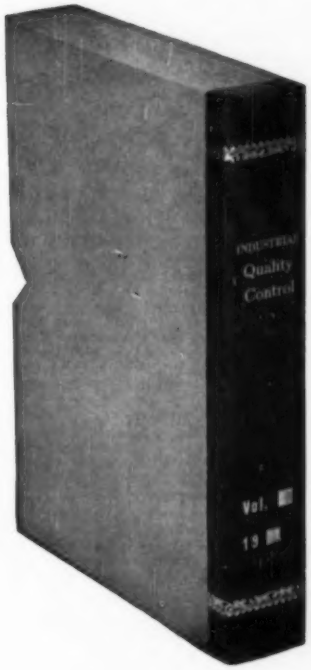

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INDUSTRIAL QUALITY CONTROL

Vol. XVI, No. 8 February, 1960

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Our Cover

We are indebted to Motorola Inc., Military Electronics Division, for our February cover picture which depicts how precision equipment of complex electro-mechanical nature successfully undergoes in-process inspection in the volume production of reliable precision equipment. Leo E. Storm, Olin Mathieson Chemical Corp., New Haven, Conn., discusses the opposite production situation—short runs—in his article, "Specification Study for Limited Production of Complex Equipment," page 12, this issue.

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☆ Organize Promote Appraise

Prescribe

Analyze

Management Bench Marks For Quality Control

EDWARD M. SCHROCK

American Radiator and Standard Sanitary Corporation, Baltimore, Md.

Where Should We Start?

This is perhaps the most frequently asked question by management people about to launch a modern quality control program. Unfortunately it is often answered incorrectly. The general problem of controlling product quality has been with us since the first time someone tried to duplicate something made previously. Just as everyone knows something about medicine, so everyone knows something about controlling quality. All too many of these things that everyone knows are wrong or inadequate for the problem at hand.

Unless the top management people have some familiarity with the modern concepts of quality control and its management, they should seek to acquire them. This is the proper place to start. Without a broad, general understanding of the nature of the field, management people will have a difficult time properly launching a new program. All too many people have gained the false impression that modern quality control is merely a glorified inspection program with a lot of mysterious statistical formulas thrown in for window dressing.

Management training can be acquired through round table conferences sponsored by such organizations as the American Society for Quality Control† and the American Management Association, through published literature, or from qualified consultants in the field of quality control. From one or more of these sources, a person in top management can gain an understanding of how modern quality control can contribute to the profit margin. Once this hurdle has been passed we come to the specific question.

ASQC LCS Codes 310; 320; 330; 331:10:000.
*Presented at the 1959 Middle Atlantic Conference, American Society for Quality Control, Atlantic City, N. J., Feb. 6, 1959.
†For example, the Management Workshop conducted in connection with the ASQC Convention in Cleveland, May, 1959, and similar workshop sessions at a management level conducted by the American Management Association in New York City at various times.

Does My Company Need a Quality Control Program?

This is not really a "yes" or "no" question. If you produce anything, quality is inevitably a consideration and you will of necessity have been doing *something* about it. The important question is whether *what* you have been doing is adequate. Have you been sorting out bad product after it is made, or have you been learning how to avoid making defectives? Making product correctly the first time is almost always much less expensive. Do you appraise the quality of your completed product and the package in which it is shipped, or wait for customer complaints to tell you something has gone wrong? Is your inspection department providing adequate and efficient information for the control of quality?

Probably the most important question you can ask is, "How much is bad quality costing us?" This brings us to the first of five steps that lead to an effective quality control program.

Analyze

It is amazing but true that people who would not expect a doctor to prescribe medicine until he had made a diagnosis, will tackle the problem of quality by trying to superimpose a technique without regard to the need for it. This is the sort of thing that Juran[1] has described as "remedies first, diagnosis later." It is a natural consequence of the attractiveness of devices that have worked in other places. It is only natural to imitate successful procedures. Unfortunately, a generally sound procedure does not necessarily work equally well in all cases, nor is it necessarily needed in all cases. Abuses of this sort have been most prominent in connection with statistical methods. Statistical methods are powerful where and when needed, but like all tools should be used only when their need is indicated.

The primary objective of the analysis should be to determine how many dollars defective product is costing the company. This will include labor, materials, and overhead for scrap, rework, and field claims. By identifying parts purchased from vendors for assembly into the final product, it can be determined whether a vendor problem exists.

In one company[2] it had been traditional to blame the vendors of raw materials for spells of bad quality in the manufactured product (glass). Parallel processing of materials from three vendors conclusively established that the ups and downs in quality occurred simultaneously with all three sets of materials. The probability of such an event occurring by chance is beyond credence. For the first time it was conclusively established that the ups and downs were due to variations occurring in the processing, not in the raw materials. Further, the causes probably constituted a major factor complex, else the production organization would probably have licked the trouble long ago.

Once the dollars for defective product have been added up (do not include routine costs of inspection or testing, except as overhead applied to all product, as these would be conducted whether the quality level is good or poor), divide them by the number of productive workers (those whose work creates, modifies, or adjusts quality characteristics of the product either through personal contact or through machinery which they regulate). Several years ago (1950) Juran[3] pointed out that this figure can be expected to approximate $500 to $1000 per year per productive worker. Inflation would make it higher now. Juran also pointed out that an effective quality control program would probably cut this figure at least in half.

The dollar valuation of defective product should be prepared by the accounting department to insure its

appropriateness and objectivity. It should cover the past two or three years. The analysis of internal losses for scrap and rework should be broken down by departments and according to product lines. This will provide an indication of the way in which efforts to improve quality should be allocated. There is no point in trying to improve a product line or department where dollar losses are so low that the cost of improvement would be greater than the reduction of loss. Similarly, there is no point in expending quality control effort on such areas as design, incoming materials, or processes unless the added cost can be offset by the potential gain. The only exception would be the establishment of minimal safeguards where an economic hazard of future deterioration exists.

A second objective of the analysis should be to determine whether the routine reporting of scrap and rework is:

(a) properly reporting all scrap and rework, and
(b) is doing so in adequate detail.

A temporary set-up to make repairs should be identified and reported as a repair operation, not as normal productive labor. All too often such temporary set-ups become standard practice. They can contribute materially to total costs. Also the reporting of defective material should identify the nature of the defects. This is necessary to identify the quality problems that require prime attention. In one foundry it was found that all pieces scrapped were lumped together and reported daily as the total number of pieces and total number of pounds scrapped. There was production sorting being performed, but there was not a single inspector from the inspection department. Until inspectors were put on the job and a detailed tabulation was prepared identifying the defects in the various product classes, no one connected with the department realized what the major quality problem was.

Once we are sure we have an adequate appraisal of the dollar loss for scrap and rework in each department, the losses should be related to the manufacturing cost through that department. Thus, if labor, material costs, or overhead increases, then the value of defective product will increase along with it and not be biased. This may be set up in tabular form as shown in Table I.

Dollar losses for field claims should be tabulated separately because of the time lag before they occur. Also, it is often impossible to relate them to a date of manufacture. Where possible, breakdowns should be made according to the date of manufacture, product class, and type of defect.

A third objective of the analysis should be to determine whether the existing inspection effort is properly related to the needs. This may come to light to some degree in connection with the prior objectives, but is important enough to merit special attention. It is not uncommon to find the greatest concentration of inspection effort at the "back-door", the purpose being to sort out defective ware just prior to shipping. This most likely will be a 100 percent inspection procedure.

The proper place to inspect is immediately after the operation which produces defectives. Defects should be caught at the earliest possible moment to avoid pouring good money after bad. Data collected at such points is most helpful in pinning down causes. Once defect causes are identified and brought under control, the ware reaching final inspection will normally require only a sample inspection.

As a part of the survey of inspection activities, consideration should be given the routine (or lack of it) for gage maintenance. Incorrect measurements are worse than none at all, for they mislead and result in wrong courses of action.

A fourth objective of the analysis should be to evaluate the reporting of quality trends. Quality never stands completely still, and unless under good control, will get better and worse from time to time in clearly defined swings of considerable magnitude; that is, it will be two, three, four, or more times as bad when at the crest of a wave of defectives as when running good. One of the reasons this is seldom appreciated is that these swings or cycles generally occur over a span of several days or a week or two, while the reporting is done on a monthly basis. The crests and valleys of the cycles are thus lost in the overall figure for the month and management never gets a glimpse of the true potentiality of the process.

Management needs to know when the defects are of the epidemic type and when of the chronic type. The line organization should correct the former, the quality control organization should prescribe corrective steps to be taken by the line organization to correct the latter. Epidemic type defects almost always consist of single cause and effect relationships. The line organization will know or can quickly find the cause and correct it. The chronic defects may arise from a hidden single cause, but more often than not arise from a major factor complex. Such cause systems are never solved by the men in the shop because of restrictions over which they have no

TABLE I—Hypothetical Data Illustrating Tabulation of Dollar Losses for Scrap and Rework in a Plant Having Three Departments

	Year Date	Mfg. Cost	Scrap	%	Rework	%	Total %
Total	Year 1955	13,145,200	785,600	6.0	498,900	3.8	9.8
	Year 1956	12,965,800	767,300	5.9	502,100	3.9	9.8
	Year 1957	13,691,300	830,100	6.1	536,900	3.9	10.0
	Jan. 1958	1,103,000	65,500	5.9	41,300	3.7	9.6
	Feb. 1958	1,206,700	70,800	5.9	48,600	4.0	9.9
	etc.						
Department A	Year 1955	3,345,100	361,200	10.8	195,700	5.9	16.7
	Year 1956	3,339,200	372,500	11.2	189,600	5.7	16.9
	Year 1957	3,363,700	373,100	11.1	196,400	5.8	16.9
	Jan. 1958	295,300	32,800	11.1	17,300	5.9	17.0
	Feb. 1958	314,400	35,900	11.4	18,200	5.8	17.2
	etc.						
Department B	Year 1955	5,874,800	141,500	2.4	152,800	2.6	5.0
	Year 1956	5,663,900	132,800	2.3	157,900	2.8	5.1
	Year 1957	5,935,100	149,700	2.5	170,600	2.9	5.4
	Jan. 1958	484,300	11,200	2.3	14,100	2.9	5.2
	Feb. 1958	497,200	10,400	2.1	14,200	2.9	5.0
	etc.						
Department C	Year 1955	13,145,200	282,900	2.2	150,400	1.1	3.3
	Year 1956	12,965,800	262,000	2.0	154,600	1.2	3.2
	Year 1957	13,691,300	307,300	2.2	169,900	1.2	3.4
	Jan. 1958	1,103,000	21,800	2.0	9,900	0.9	2.9
	Feb. 1958	1,206,700	24,500	2.0	16,200	1.3	3.3
	etc.						

control. They cannot devote full time to the problem, or cut across departmental lines in investigations; they are almost always unfamiliar with the technology of modern quality control, and they are often unable to bring an unbiased point of view to the problem.

When we are satisfied that we have a good analysis of the quality problem, we are ready for the second step.

Prescribe

By now we should have a lot of facts assembled which in themselves would enable us to write a good prescription for dealing with the quality problem, but there is one more indispensable step that must be taken first.

Have a conference with each of the department heads. Find out what each thinks about the existing quality control and inspection procedures. You are almost certain to find that some of them have things to get off their chests. They may also have some constructive ideas that should be incorporated into the planning. These conferences might well be conducted simultaneously with the first step (analysis).

If for no other reason, conferences with department heads are necessary for the human relations aspect of quality control management—giving the responsible individuals a voice in the program. They will also have an opportunity in such conferences to gain a better understanding of modern quality control.

A written program should be prepared which outlines the present practices, and prescribes such changes as are indicated in each department. This written program should be reviewed with each department head to obtain his concurrence before it is issued. When it has been agreed to by the plant management and anyone else concerned in the management, it is ready to serve as a guide for launching the program.

The program should include a budget for added costs that will be created by the new department. If we consider that an effective program should cut quality losses at least in half, we can afford to spend some portion of this amount. It is suggested that this portion might be approximately one-fifth of the potential savings (which is at least one-half the total cost of defectives). This basis has served well in the writer's experience. Of the amount budgeted for the department, about one-half to two-thirds should be allocated for personnel. The remainder will be required to cover supplies, special test and inspection equipment, and other overhead items.

The written program should spell out the number and kind of people needed to staff the department. This is a major aspect of the entire program and constitutes the third step.

Organize

Juran[4] has pointed out that there are three broad areas of activity in a quality control department. One is the inspection activity. It is concerned with incoming materials, process inspections, final inspections, and the maintenance of instrument accuracy. Most production organizations will have developed this area of activity prior to a modern quality control program. Even so, it is highly probable that some of the inspection activities can be greatly increased in their effectiveness when appraised in the light of modern inspection procedures and quality control techniques.

Another area of activity is quality control engineering. Without a modern quality control program, it is almost certain there will have been little or no such activity. This involves inspection planning, defect prevention, and the use of statistical methods.

For a variety of reasons (most of which are generally superficial) some companies have the chief inspector and quality control manager independent of each other and reporting to the same manufacturing or management head. This arises from a misunderstanding of the nature and function of inspection. The nature of inspection is to put an objective evaluation on quality characteristics at any appropriate stage from raw material to completed and packaged product (field sampling may also be in order at times). This may be done visually (beauty defects), with measuring devices (micrometers, voltmeters, etc.), or by complex tests (chemical analyses, life tests, etc.) in which the services of a specialized laboratory will be required.

The function of inspection is twofold: one, to judge the acceptability of a given lot of material or a process (should it continue to run or be adjusted); and two, to provide the factual information needed by the quality control engineer to identify the causes of defects, and to apply statistical tests or analyses where needed. In order to carry out this latter function properly, it is apparent that the inspection procedures (where, how done, etc.) must be planned by the quality control engineer.

The rule-of-thumb methods which inspection has traditionally used are loaded with procedures which, how ever well intended, often fail to accomplish their intended purposes, and at best, often do so very inefficiently. It has been an all too common practice for companies to staff their inspection departments with cases of partial disability, faithful employees who can no longer do heavy work. This is humanitarian, but often devastating to the proper control of quality.

Deming[5] has pointed out what sampling is and is not (everything the inspector takes is a sample). Everyone in an inspection supervision job should understand just what these principles are and the limitations on sampling procedures.

The quality control engineer is fairly new on the industrial scene. Many engineering schools are now offering courses in the subject, and in due time degrees will be offered just as in other engineering fields. A large number of courses are available with respect to the statistical tools of quality control engineering. In due time there will be a greater emphasis on some of the other areas of quality control work that are just as important and often more so.

The quality control engineer is the person best equipped to plan the data collection necessary for ferreting out the complex and hidden causes of defects. He is seldom in a position to do the entire job himself, as he is usually untrained or inexperienced in the subject matter field. This means he must work closely with the technological expert in the subject matter field (chemist, electrical engineer, ceramist, etc.) Many companies seeking to hire a quality control manager make the mistake of insisting that he be an electrical engineer, metallurgist, etc. This is desirable if it can be obtained, but for two reasons it should never be a prerequisite: one, quality control principles are universal, they apply regardless of the subject matter field; two, anyone truly competent in a subject matter field probably will not have had time to become truly competent in the quality control field (and vice versa).

The third area of activity is quality assurance. This involves check inspection (a small sample check on the correctness of the regular inspections being performed), audit inspection (a small sample check on

the correctness of the completed product and its package), and executive reports (the kind and frequency of information to be fed to upper management levels and other portions of the line organization.) The inspections involved should be performed by inspectors in a separate group and under supervision separate from the chief inspector.

The number of people needed to staff a quality control department will vary widely with the industry and size of the company. A very rough bench mark is one quality control engineer for each 200 productive employees and one technician for each engineer. Regardless of the number of people involved there are nine job functions involved.

One is the management of the quality control program. The dearth of experienced and competent managers means that it will be a rare company that has a fully qualified individual within its ranks. The quality control manager is sometimes placed at too low an organizational level. (I have never seen one placed too high, although obviously it could be done.) He should report to such level as represents the policy formation for quality in terms of market demand, costs, and manufacturing considerations. This will often be the plant manager or director of manufacturing.

A second is supervision of inspection. The chief inspector should be familiar with modern sampling procedures and the general principles involved. It is not necessary that he know or understand the mathematical statistics underlying sampling theory, but he should know such things as what is meant by single, double, multiple, and sequential sampling, and the advantages and disadvantages of each, the meaning of an operating characteristic curve, and producer's and consumer's risks.

A third is inspection. A principle consideration is that the inspector be qualified for the specific duties required. Where visual defects are involved, vision should be good or adequate glasses worn. Color blindness cannot be tolerated where color matching is involved. Manual dexterity must be adequate for the procedures required.

Inspectors will sometimes be skeptical of modern sampling procedures and will cling to the idea that the only proper way to inspect is to examine each piece. Sometimes this is correct, but very often it is not. The chief inspector should be prepared (with the collaboration of the quality control engineer in some cases) to run special tests to demonstrate to the inspectors the soundness of the procedures specified.

A fourth job function is the supervision of quality control engineering. In many organizations this will be done by the quality control manager. In many organizations this will be supervisor will be required. Such an individual should have qualifications similar to the quality control manager.

A fifth job function is quality control engineering. Such an individual should be familiar with the modern concepts of quality variation and its appraisal.

A sixth is the quality control technician. He works as a team with the quality control engineer, collecting and tabulating data specified for investigations of causes of defects. He should also be able to summarize data under the direction of the quality control engineer, and to prepare charts and tables as directed. He should be alert to unusual conditions that may occur in connection with an assignment and be able to record and report them accurately.

A seventh is supervision of quality assurance. This person should have the qualifications of a chief inspector, and in addition should be adept in preparing executive reports. This requires the ability to analyze and interpret data and to present it in a form digestible by management.

An eighth is quality assurance inspection. These inspectors should be the most experienced and best qualified of all the inspectors. Since a part of their work will be to reinspect product inspected by the regular inspectors, they should be tactful and able to get along well with people. The chief inspector can help by making clear to his inspectors that check inspection is much more than a device to catch errors on the part of inspectors. It is an impersonal device to test the entire procedure of specifying what is to be inspected, how it is to be inspected, what equipment is to be used, and the effectiveness of the inspector. Errors may be due to faulty instruction, faulty equipment, wrong standards, or wrong procedures as well as errors on the part of the inspector. The inspector should understand that check inspection is intended to help him do a better job.

The ninth job function is secretarial and clerical work. The special requirement here is that there should be a liking for handling numbers. There will be many records to be

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maintained, and data posting and summarizing. Some chart work may also be required.

In all probability it will be necessary to go outside the existing personnel to obtain a quality control manager, the quality control engineering supervisor (if required), and the quality control engineers. The balance of the personnel required can often be recruited from existing employees.

Promote

One of the most effective ways to promote a new quality control program is to organize a quality committee. The purpose of this committee should be to guide the quality control program, to review quality progress, and to recommend the direction of effort to improve quality.

In addition to the quality control manager and chief inspector, the committee should consist of such people as the plant manager, head of each production department, heads of design engineering, manufacturing engineering, engineering specialist such as chemist or metallurgist, sales, and accounting. This group should meet monthly at first. In addition to the prime purpose as described above, the meetings of the group serve to provide a generous interchange of information about how each department functions within itself. This is an important educational by-product of the committee meetings. Working together, the group should develop an acceptance and support of the program even though they will not understand the details of some of the modern quality control techniques.

This group can suggest tests and experiments to find defect causes. These can then be carried out by the quality control department and results reported at the next meeting. An agenda should be prepared for each meeting which summarizes quality performance by product lines and defects. Dollar evaluations should be prepared to indicate areas of greatest potential savings. The results of special tests and experiments should be reported. *Getting lots of pertinent facts down on paper is essential to making progress.*

Organizing a quality control department will undoubtedly add costs at first. As defect prevention becomes effective, the added costs will be overtaken and passed. Individual experiences will vary considerably depending upon the potential and adequacy of the program, but in general it can be expected that about six to eighteen months will be required for the program to reach the break-even point. This is the point at which the dollar value of the reduction in scrap and rework equals the dollars of added cost. Cutting the dollar value of scrap and rework to half its former level may be expected to take about three to five years.

Appraise

Evaluating the added costs and the dollar value of scrap and rework should be done by the accounting department. Organizations that are large enough may assign a member of the accounting department to full time work on quality control.

A generally suitable reference point for savings is the dollar value of scrap and rework for the past three years. Table II shows a tabular form on which results may be reported. The first pair of columns give the year or month, and the dollars of manufacturing cost (labor, materials, and overhead). The next pair shows first the dollar value of scrap and rework at the average rate for the past three years, and second the actual value of scrap and rework. The next pair shows first the savings for the month and then the cumulative savings. The next pair shows the added costs for the month and the cumulative added costs. The last pair shows the net savings for the month and the cumulative net savings. Brackets represent negative figures.

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TABLE II—Dollar Appraisal of Quality Control Program
(Data are hypothetical for illustrative purposes)

Month	Mfg. Cost	Scrap & Rework at 9.85%	Actual Scrap & Rework	Savings		Added Costs		Net Savings	
				Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
Jan. 1958	1,103,000	108,646	106,800 (9.68)	1,846	1,846	3,650	3,650	[1,804]	[1,804]
Feb. 1958	1,206,700	118,860	119,400 (9.89)	[504]	1,342	4,821	8,471	[5,325]	[7,129]
Mar. 1958	1,235,600	121,707	122,572 (9.92)	[865]	477	6,354	14,825	[7,219]	[14,348]
Apr. 1958	1,195,300	117,737	107,816 (9.02)	9,921	10,398	8,451	23,276	1,470	[12,878]
May 1958	1,243,600	122,495	110,805 (8.91)	11,690	22,088	9,873	33,149	1,817	[11,061]
June 1958	1,465,100	144,312	135,229 (9.23)	9,083	31,171	10,410	43,559	[1,327]	[12,388]
July 1958	1,379,200	135,851	119,163 (8.64)	16,688	47,859	10,250	53,809	6,438	[5,950]
Aug. 1958	1,246,300	122,761	105,312 (8.45)	17,449	65,308	10,100	63,909	7,349	1,399
Sept. 1958	1,345,800	132,561	107,799 (8.01)	24,762	90,070	10,175	74,084	14,587	15,986
Oct. 1958	1,256,300	123,746	103,142 (8.21)	20,604	110,674	10,175	84,259	10,429	26,415
Nov. 1958	1,378,400	135,772	109,721 (7.96)	26,051	136,725	10,200	94,459	15,851	42,266
Dec. 1958	1,437,700	141,613	108,978 (7.58)	32,635	169,360	10,235	104,694	22,400	64,666
Jan. 1959	1,333,400	131,340	104,539 (7.84)	26,801	196,161	10,220	114,914	16,581	81,247

Quality Control Without Conflict

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QUALITY CONTROL WITHOUT CONFLICT would seem to be accomplished if:

(1) every operator built just the correct amount of quality into every product he turned out;

(2) every foreman considered quality as equally important as quantity, costs, and the other factors for which he is responsible;

(3) every other manager considered quality as important as his own special responsibility; and

(4) top management considered the effects upon product quality of every decision they make. This may be a fair expression of the quality control manager's private utopia.

This article will point out some of the things that Industrial Psychology and the other social sciences have provided management in the way of tools to bring these things about.

Research conducted by psychologists and other social scientists has thrown considerable light on the sources of motivation and morale of employes.[1] They are, through continuing research, trying to find ways to apply what is known without conflict. Practical management men have increasingly found ways to put these findings into practice.[2]

Some of these findings that seem most significant to quality control work are the following:

(1) Small work groups are most effective from the standpoint of quality and quantity; and they have the highest morale. These small work groups are most effective when set up by management.

(2) Men given an opportunity to participate in decisions are more effective in carrying them out.

(3) Men who have knowledge of their results are more efficient from both a quality and a quantity standpoint.

(4) The most important factor in both the efficiency and morale of the work force is the supervisor.

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Size of the Work Group

A striking outcome of research on motivation and morale in industry has been to reveal the significance of the small work group,[3] where management has taken the initiative in setting up these groups. Such a positive step is shown to be necessary by research which points out that self-organized groups, and those organized by unions, tend to buck the purposes of the formal organization.

It is apparent that the supervisor plays a crucial role in the planned, deliberate organization of small groups into teams working toward the goals of the organization.

Both the studies conducted by the Michigan Survey Research Center[4] and some British experiments[5] lead to the conclusion that small work groups are more productive and have higher morale. In fact, the British experiment shows a progressive decrease in output from groups of size two through nine through groups of size 50 and over. The findings show that members of small groups more frequently had accurate information as to how they were doing from day to day than larger groups. Also the small group allowed its members to get to know each other well and to trust each other.

This last point suggests that management might not only form small work groups but make an active effort to consider workers' preferences in the selection of members of the work team. Several studies[6] have shown that groups arranged in this fashion outproduced both in quantity and quality even small groups not so arranged. The savings in production costs in one study were five percent and, in addition, there was a drop in labor turnover. Even where it is impossible to arrange work groups on the basis of worker preference, it would seem that much more could be done in arranging groups on the basis of common interest or experience. This might be done both in new groups and in preserving existing groups in the loan and transfer of employees.

This finding would seem of use to quality control managers in encouraging supervisors to experiment with sizes of groups and to use their influence with other managers to create a climate where this becomes possible. They might make further use of it in quality training programs as well as in preparing reports of quality results.

Participation

Another finding that should prove useful is the dramatic influence of participation upon efficiency. One of the most difficult of management problems has been that of overcoming resistance to change. In one study,[7] participation was used to attempt to bring output up to standard after a change in the method. Prior to the study it had taken eight weeks to reach standard under the new method. The study involved a control group (treated as in the past—a meeting explaining the change and answering questions), and an experimental group. In the experimental group, the reason why a change was necessary was explained—the need to meet competition. Then the group was asked what to do about it. They worked out the details of the change and voted to put them into effect at once. In the control group, output dropped drastically and showed no improvement at all by the end of the experimental period of 40 days. The experimental group had passed the prechange output at the end of the second day, and by the end of the experiment was 14 percent above the prechange output.

At U. S. Steel, this principle is made use of in weekly quality meetings between the foremen and their men where hourly employees are invited to make suggestions in methods for quality improvement.[8]

Another company held a meeting with the officers of the union in which the need for quality control, its effect on job security, and the proposed quality plan were presented. The union officers asked questions and made suggestions. They then asked for a short article on quality control that they could give to union stewards.[9] They were squarely behind the quality control program.

It is well-known that rank-and-file employees know the answers to many of our thorniest problems. Many quality control men have discovered troublesome sources of variation during personal talks with the men.

Psychologists point out that participation is the key to the strongest kind of motivation—that which comes from the individual who understands and accepts the goals to be achieved.

It should be noted at this point that the successful supervisor makes use of this approach. This suggests that if the supervisor understands and accepts the goals of the quality control program his entire section will.

Beware of the participation, however, if you have reservations about it. The "appearance of participation" is quite likely to backfire and result in even stronger resistance. Limits can be placed upon participation, especially if the reasons for limits can be logically explained, but beware of "pseudo-participation."

Knowledge of Results

Another finding of psychological research is the efficiency derived from knowledge of results. Most of us are familiar with the universal question, "How am I doing?" Answering this question by allowing the questioner to answer it himself provides a bonus in efficiency.

If foremen understand the goal and the principles of quality control, they will be able to answer their own questions and those raised by his employees. Many organizations conduct training programs in quality control for this reason.

Some have taught operators how to make the necessary calculations and to plot values on control charts. Charts are hung on the operators' machines. One company[10] started the program cautiously. Picking only the two best operators on each shift, they were trained in the purposes of quality control and the techniques of sampling and plotting results. A trial period of one month was decided upon to obtain the reactions of employees. During the first week, however, several dozen control charts appeared on other machines. These employees had found out what the charts were all about and had made them for their own machines. This forced a speed-up in the quality training program and resulted in placing the entire plant under a quality control program months earlier than expected. It hardly needs mentioning that the knowledge of the results available to employees brought about an immediate improvement in quality.

In furnishing knowledge of results, whether to employees or supervisors, the quicker the better. The sooner results are known after their occurrence, the better the results.

Knowledge of results requires *communications media*. Various companies have made use of the house organ, weekly newsletters, posters, and scrap displays to communicate to employees the goal of the quality program, as well as results achieved. Minnesota Mining and Manufacturing Company uses two films as part of their employee indoctrination program to help employees see the relationship between their job security and quality. The first film shows how the products of the company are used by customers. The second film shows employees the effects of quality errors when the products are in use.

The findings so far discussed provide an excellent start for the executive who wants to take positive action in applying research results to management. It is apparent, however, that the way these findings are applied is largely a function of the quality of supervisors. In fact, *perhaps the most significant single finding from human relations research is the demonstration of the key role of the first-line supervisor in helping to raise levels of production and morale.*[11]

Study after study[12] has shown that the quality of supervision exercises a tremendous influence on not only quality and quantity of output, but on employees' absence and turnover rates.

Such findings clearly support the view that the efficiency and morale of the worker are functions of supervisory skill (1) in tapping the motivation of the worker, and (2) in integrating workers into groups which accept organizational goals and willingly help achieve them. However, research has also indicated that the supervisor's ability to do these things is a function of the *management climate* created by his own superiors. There is evidence that supervisory training may do little or nothing to actually improve the quality of supervision unless the *management climate* at higher levels encourages the use of these skills by supervisors.

Effective results in stimulating supervisors at all levels to accept their responsibilities and to apply skill in promoting motivation and morale can only occur where supervisors see themselves as being members of a management team. In accomplishing this objective, there are at least two basic requirements: (1) give him a management job (where his boss works out with him the results expected in his department and turns him loose to accomplish them, and where his boss's boss does the same thing with him), and (2) restore to lower supervisors the status they have lost through unionization and the proliferation of the use of staff in industry.

Job Integrity

The issues involved regarding the problems of the supervisor are well presented by the following story.*

> Abie was a foreman in a clothing manufacturing plant. He was a busy man. He had to hire men and train them, schedule production, lay out the work, see that quality and quantity of output were maintained, see that machines worked, keep within his budget and so on and on. One weekend he came home and told his wife, "Mamma, I don't have to find, hire, and train men anymore. We got a personnel manager." The next weekend he came home and said, "Mamma, I don't have to schedule production anymore. We got a production control man." The next weekend he came home and said, "Mamma, I don't have to lay out the work anymore. We got a motion study man." The next weekend he came home and said, "Mamma, I don't have to worry about quality anymore. We got a quality control man."
>
> Finally, mamma turned to Abie and said, "Abie, what do *you* do down at the plant?" Abie thought about this all weekend and when he got to the plant on Monday morning the union organizer came to him and said, "Abie, join the union."
>
> Abie said, "I can't join the union. I'm a manager." The union man said, "You are? What do you manage?" So Abie joined the union.

This is the familiar problem of staff-line conflict. And at first it appears to be a dilemma. How do you make use of the specialized knowledge needed to run a modern-day business and still maintain the integrity of the supervisor's job?

We must solve the dilemma. We need the technical knowledge of the specialist. We must maintain the integrity of the supervisor's job because upon this rests the efficiency of the company. Good supervision is the key to quality and quantity of production as well as morale. Good supervision is possible only when the supervisor is allowed to be a manager—to run his department—to make decisions—to be the one boss. Only then can he do the things that make for good operation.

But how is this done? The first solution is to see that everyone, especially staff men, understand organization relationships.[13] This means that they as well as the supervisor must understand that neither is the other's boss. The staff man must understand that it is his job to help and that he can't help unless his help is accepted.

It is at this point we hear the cry: "Those stupid foremen. If I just had the authority to carry out my program." Or "Why should the foreman get credit for what I did?"

It shouldn't be necessary to point out that to give the staff man the authority is to take it away from the foreman. And to give the credit to the staff man makes the improvement a reflection on the foreman.

On this point of understanding organization relationships, it should be understood that the term "staff" as employed here refers to the service departments and to what are sometimes called functional relationships. The point is that these people as well as the foreman and his subordinates must understand that the staff man has no authority over anyone except his subordinates in his own department. The "authority over subject-matter" argument is no solution. But it does help to know that information does not have to follow the chain of command.

Another solution is to have all the staff men report to the supervisor.[14] This conflicts with what the staff man wants (to report to top management) but look what often happens when you don't have staff men report to the supervisor. A large metal fabricating firm practically fell apart because of the quality vice-president. He had quality control men reporting to him to match each level of plant supervision. Where there was a plant manager, there was a plant quality manager reporting to the vice-president of quality. Where there was a superintendent of production, there was a superintendent of quality reporting to the same vice-president. And so on. You know what happened. The quality men began to tell the production men when to start and stop, how to operate. Finally, the production men just wouldn't do anything. Production decreased; quality men didn't know the machines. Quality reached a new low.[15]

Drucker suggests that to insure that staff men do not dilute the supervisor's authority, we ought to change our thinking about delegation of authority. Instead of thinking about delegation of authority from the top down, we ought to delegate from the bottom up. Only the things the foreman can't do will be delegated upward.[16]

Another suggestion is to eliminate staff whenever the line can do the job reasonably well. But to either eliminate the staff man or have him report to the foreman may lose part of the gain we expect to get from employing the staff man—consistent use of the specialized knowledge where it is needed.

A more acceptable solution to both foremen and staff men is the principle of "double credit." This idea is attributable to Ed Schleh,[17] a Minneapolis management consultant. The approach is to write job descriptions in terms of "results expected," not functions or activities. When the results expected require that the foreman work with the staff specialist, write the job descriptions of both so that they work together and get it done and *both get credit.* The foreman is responsible for the work the staff is doing. This means that they must get full credit for everything that is done. If you want to get full cooperation between staff men and foremen, they must both get full credit. This means giving double credit for the same result. It may even mean both get credit when one does all the work. From a practical point of view, you get more total results when you do this.

The foreman should get full credit for improved quality that he or the quality control man has developed. This makes the foreman much more interested in getting help from staff people, because good help can only make him look better. Of course, the staff man must get full credit, too. You can't expect staff men to keep working with no credit for results.

A further solution soundly based on psychological research is the approach Kimberly Clark uses with its industrial engineers.[18] They call it the "proximity principle." They insist that their industrial engineering men know everyone in the plant well before they are given an assignment. They are expected to see and talk to every foreman every day of the week. When they make a study they do it only with permission of the foreman and stay in the department until the standard is accepted. And no standard is installed until the foreman and the men involved accept it. They claim that by insisting that the staff men know everyone well their selling job is half done.

All of these approaches are based on the research findings that demonstrate that the supervisor is the key to efficiency and that he cannot be effective unless he is a manager. This means that he must be able to run his department; he must see that he is permitted to run it. To the extent that staff men want to accomplish their results, they can do so by using their influence to build up the foreman's job.

*Attributed to Professor Rosensteel of Loyola University, Chicago.

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Specification Study

LEO E. STORM

Introduction

In production of complex electronic equipment a manufacturer is faced with statistical quality control problems which are somewhat different than those encountered in mass production. Production of this type of equipment is often limited to as little as four or five units per month. Many theoretical studies and engineering man hours are spent in designing the equipment and theoretically determining the specifications; but it is sometimes forgotten that industrial operations seldom follow *strictly* a predicted operational pattern based on initial theoretical specifications. One of the objects of statistical quality control is to provide a numerical evaluation of the operational aberrations.

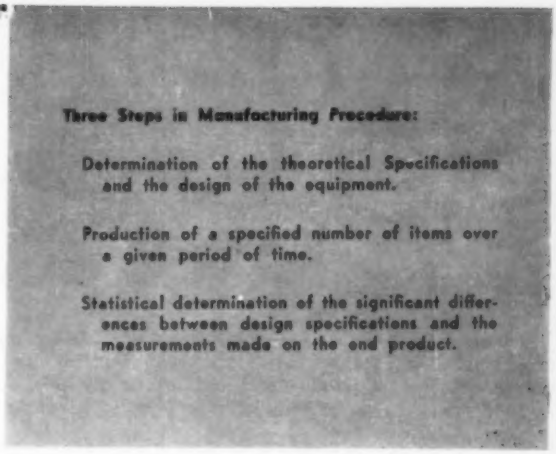
In statistical quality control techniques, applied to production of numerically limited units, it should be recognized that the application of more efficient statistical methods is necessary if we are interested in greater quality assurance for a product. The study of these units should be analogous to evaluating a pilot run in mass production; future production of a product often depends on these runs. After these initial pilot runs, some manufacturers, who are interested in continuous quality evaluations, initiate quality control charts for the average and the range. These methods are essentially an approximation to the methods presented herewith. The difficulty in the manufacture of complex equipment is evidenced by the fact that few manufacturers get out of the pilot run stage and into mass production. Human lives and possibly our national security may depend on the proper evaluation of the equipment. For these reasons, if for no other, the manufacturing procedure should involve essentially the following three steps:

1. Determination of the theoretical specifications and the design of the equipment.
2. Production of a specified number of items over a given period of time.
3. Statistical determination of the significant differences between design specifications and the measurements made on the end product.

This procedure should be a continuously scrutinized operation aiming at the closest possible agreement between the theoretical design specifications and the measurements made on the end product.

Statistics can and should be used in all of the steps outlined above, but this article is concerned only with the statistical evaluations involved in the third step. The goal in this case is to obtain a specification which is a

For Limited Production Of Complex Equipment


Three Steps in Manufacturing Procedure:
Determination of the theoretical Specifications and the design of the equipment.
Production of a specified number of items over a given period of time.
Statistical determination of the significant differences between design specifications and the measurements made on the end product.

Olin Mathieson Chemical Corporation, New Haven, Conn.

form of a guarantee for the quality of the production items. One problem is presented as an example to demonstrate some of the differences one may encounter between theoretical specifications and statistical specifications.

Statement of the Problem

For this problem it is assumed that the production of a type of navigational computer equipment is limited to 25 units every six months. This number of units was selected to demonstrate the solution to this problem, but the statistical evaluation procedures used here can also be applied to as few as five or ten units. With the multiplicity of components in the units, 100 percent inspection is necessary to detect anything that may produce unsatisfactory computer outputs. In this equipment it is necessary to test various levels of output. For example, one of the outputs may be produced by equipment tested in the laboratory simulating various altitudes; other outputs may be those of air speed, wind direction, wind speed, etc. For theoretical reasons the errors in some of the outputs at the various levels are not uniform, thus making it necessary to assign different tolerances to some of the levels.

In order to determine if the theoretical assignment of common tolerances for different nominal values is justified for the production test results, Bartlett's test for homogeneity of variance is used. The initial hypothesis in this test is that the population value for the variance at each level is equal. This may be considered as analogous to the hypothesis that the tolerance at level 1 is equal to the tolerance at level 2 . . . . . is equal to the tolerance at level k. To identify the individual observed tolerances which are significantly different from the theoretical tolerances, the chi-square test criterion is used.

As the operation of the equipment is very likely to cover all levels of the outputs, an evaluation of the overall performance of the equipment is desired. By considering the nominal value (or mean value) as the mean of the theoretical nominal value minus the observed nominal value for each level, the analysis of variance techniques may be used as a substitute for control charts for the average. If the variances are shown to be homogeneous by Bartlett's test, the standard analysis of variance techniques may be used. In a problem where there is heterogeneous variances, Snedecor's approximate method for the analysis of variance with heterogeneous variances is used. To separate the individually observed nominal values which are significantly different from the theoretical nominal values, Student's t-test is used.

Bartlett's Test for Homogeneity of Variance

The use of Bartlett's test[1,2,5,11] will lead to essentially the same conclusions as the control chart for ranges, if the recommended subgroups and sample size were available for determining control limits on the range charts. Bartlett's test requires more calculations, but it has the advantages of being more sensitive and precise.

The first concern is to construct a mathematical model on the basis of the experimental data. The next step is to set up an initial or null hypothesis concerning this model, and perform statistical test of hypothesis for deciding whether to accept or reject the null hypothesis. The procedure is usually known as statistical tests of hypotheses, and in its most general formulation is a type of decision-making based on probability.

In this problem the initial hypothesis is made that the tolerances for all levels of an output should be identical. Or in statistical terminology the assumption is that the k empirical variances $s_1^2, s_2^2, \ldots, s_k^2$ are all estimates of the same theoretical variance, σ^2. Therefore it is necessary to test the hypothesis:

$$\sigma_1^2 = \sigma_2^2 = \ldots = \sigma_k^2 = \sigma^2 \qquad (1)$$

where σ_i^2 is equal to the mean value of s_i^2, before one can pool the k empirical variances to form a single estimate s^2 of σ^2. If this hypothesis is correct, a multiple of σ (usually 3σ) will be used to set the tolerances for all levels of the outputs.

In a development of Bartlett's test, A. Hald[11] has shown that

$$-\frac{1}{c}\sum_{i=1}^{k} f_i \ln\left(\frac{s_i^2}{s^2}\right) \qquad (2)$$

has approximately a chi-square distribution with $(k-1)$ degrees of freedom. In formula (2), c is a factor used to correct for bias and is functionally related to the degrees of freedom;

$$c = 1 + \left[1 + \frac{1}{3(k-1)}\right]\left[\sum_{i=1}^{k}\left(\frac{1}{f_i}\right) - \frac{1}{f}\right] \qquad (3)$$

where

$$f_j = n_i - 1$$

$$f = \sum_{i=1}^{k} f_i$$

For computations (2) may be written

$$\chi^2 \cong \frac{2.3026}{c}\left(f \log s^2 - \sum_{i=1}^{k} f_i \log s_i^2\right) \qquad (4)$$

in which one may put

$$\log s_i^2 = \log SSD_i - \log f_i \qquad (5)$$

where

$$SSD = \sum_{j=1}^{n_i} (x_j - \bar{x})^2$$

for each of the k groups.

This method may be used where there is an unequal number of observations for each level, but for the present problem it will be required that there be the same number of observations for each level.* Therefore $f_1 = f_2 = \ldots = f_k = f_o$ and $f = \sum_{i=1}^{k} f_i = k f_o$, so that one obtains

$$\chi^2 \cong \frac{2.3026}{c} kf_o \left[\log s^2 - \frac{1}{k}\sum_{i=1}^{k} \log s_i^2\right] \qquad (6)$$

where

$$c = 1 + \frac{k+1}{3kf_o} \qquad (7)$$

If the k observed variances and the corresponding values of s^2 are substituted into (6), a chi-square value is obtained which may be compared with a percentile value of chi-square for (k—1) degrees of freedom. If the computed value of chi-square exceeds the percentile value of chi-square, χ_p^2, (where P is usually chosen as 0.95 or 0.99), the test hypothesis is rejected. When the k values of s^2 deviate only slightly from one another, a low value of chi-square is obtained. Therefore the test hypothesis is rejected only if chi-square is large. It is possible, however, that values of chi-square below the 0.05 or 0.01 percentile values may be considered as criteria for investigation. If the data come from a separate source, the values obtained may have been selectively reported to appear more uniform, or the sensitivity of the test equipment or measuring device being used may be behaving in an erratic fashion.

The above test is supplemented by a detailed investigation of how the k-s^2 values are distributed by computing k estimates of chi-square; denoting this by

$$\chi_i'^2 = \frac{f_i s_i^2}{s^2} = \frac{SSD_i}{s^2} \qquad (8)$$

For each $\chi_i'^2$ value locate in the chi-square table the two values of χ^2 between which lies the value of $\chi_p'^2$ in question and register the corresponding "P-interval". If the test hypothesis is correct, it is to be expected that the number of $\chi_i'^2$ values lying in suitably chosen P-intervals deviate only at random from the theoretical number.

When the distribution found and the theoretical distribution are compared it is often possible to identify variances causing significant deviations from the test hypothesis.

Application of Bartlett's Test

In Table I is tabulated the individual measurements made on 25 units of a navigational type of equipment for one type of output tested at 13 different levels. For security reasons the source and type of measurements have not been indicated; and the data have been coded so as not to materially affect the analysis, but so as not to represent the accuracy or measurements made on any particular type of equipment.

For the present problem, it is assumed that the measurements are normally distributed. Alternatively one may secure some verification for this by graphical methods on normal-probability paper, although these methods are usually recommended for larger sample studies. If by the graphical methods or for theoretical reasons,

*For a numerical example of the case where there is an unequal number of observations, and for a more complete development of the theory underlying this analysis, the reader is referred to Ref. (11).

TABLE I—Tabulation of 25 Individual Measurements for One Output at 13 Different Levels:
(Data recorded as deviations from nominal values)

Nominal Values												
0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
1.0	0.4	−0.3	−0.2	−0.3	1.0	−0.9	−0.8	1.2	−0.1	0.7	0.9	1.2
0.1	0.2	0.5	0.1	0.2	2.0	0.1	−1.6	0.5	−1.5	0.1	0.0	−0.2
0.1	0.0	0.1	0.3	0.3	−0.3	−0.3	0.8	1.4	0.7	0.5	0.5	0.3
0.8	0.0	−0.7	−0.5	−0.6	−3.1	−1.5	−0.1	1.5	3.7	0.2	0.4	0.7
0.1	−0.2	−1.3	−0.7	−1.0	−3.3	−1.4	−2.2	1.5	2.9	0.7	1.0	1.0
1.2	0.2	0.6	0.4	0.5	0.3	−0.1	−0.2	1.1	1.1	0.4	0.4	0.4
0.1	0.0	0.4	0.2	0.2	−0.2	−0.9	−0.8	1.2	0.7	0.0	−0.1	−0.2
0.7	0.1	−0.6	−0.4	−0.6	−0.9	−1.4	−1.1	1.1	1.0	0.3	0.4	0.6
1.5	0.5	0.6	0.3	0.3	−0.1	−0.4	−2.5	0.8	1.3	0.3	0.3	0.1
−0.4	−0.2	−0.5	−0.1	−0.2	0.1	−0.6	3.8	1.6	0.8	0.8	0.9	1.0
0.8	0.1	−0.8	−0.5	−0.7	−1.7	−1.1	0.2	1.2	2.2	0.6	0.7	1.2
0.7	0.1	−1.1	−0.6	−0.8	−1.7	−0.2	−3.7	0.4	1.8	5.8	0.8	0.9
−0.2	−0.7	−0.6	−0.3	−0.4	−3.4	−0.8	4.0	1.3	3.5	0.3	0.4	0.4
1.3	0.5	0.6	0.3	0.4	0.1	−1.0	−3.0	1.4	0.4	0.1	0.1	0.2
−0.1	−0.3	−1.1	−0.9	−1.1	−3.7	−0.9	−2.1	0.2	2.8	0.1	0.3	0.4
0.8	0.0	−0.4	−0.2	−0.2	0.4	−1.1	0.4	1.8	0.1	0.4	0.5	0.5
1.1	0.5	0.5	0.3	0.3	2.0	0.2	−2.7	0.7	−1.5	0.2	0.2	0.1
1.0	0.6	−0.2	0.1	0.1	−1.1	0.0	−0.8	1.1	2.3	0.8	1.0	1.1
0.7	0.2	−0.1	0.0	−0.1	0.2	1.0	1.9	0.1	0.9	0.9	0.9	0.8
1.2	0.6	−0.2	−0.1	−0.2	0.2	0.2	−1.8	0.6	0.8	0.6	0.7	0.7
1.2	0.4	0.1	−0.1	−0.1	0.9	−0.6	−2.8	0.5	−0.5	0.2	0.2	0.5
−0.5	−0.3	−0.9	−0.9	−1.0	−2.0	−1.1	−2.5	−0.1	0.9	−0.3	−0.3	−0.2
0.9	0.3	0.0	0.0	−0.1	0.5	−0.1	−2.0	0.7	0.7	0.5	0.6	0.6
0.7	0.0	−0.2	−0.2	−0.2	0.3	−0.6	−1.6	1.1	0.2	0.3	0.3	0.2
1.1	0.7	0.4	0.3	0.3	−1.0	−0.7	−3.3	1.6	3.2	0.8	0.8	1.0

TABLE II—Calculations for Bartlett's Test

Calculation	Nominal Values 0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	Total
n	25	25	25	25	25	25	25	25	25	25	25	25	25	325
S	15.9	3.8	—5.2	—3.4	—5.0	—14.5	—14.2	—24.6	24.5	28.2	10.1	11.9	13.3	
S^2 / n	17.87	3.32	9.32	4.04	6.36	69.19	16.84	120.94	30.33	78.76	6.21	8.65	11.53	
SSD	10.1124	0.5776	1.0816	0.4624	1.0000	8.4100	8.0656	24.2064	24.0100	31.8096	4.0840	5.6644	7.0756	256.8040
f	7.7576	2.7424	8.2384	3.5776	5.3600	60.7600	8.7744	96.7336	6.3200	46.9504	2.1296	2.9656	4.4544	312
$s^2 \times 10^4$	3232	24	24	24	24	24	24	24	24	24	24	24	24	
log s^2	3.5095—4	1143	3433	1491	2233	25.325	3656	40.306	2633	19.563	887	1244	1856	46.2207—4(13)
$\bar{X}$	0.636	3.0580—4	3.5357—4	3.1735—4	3.3489—4	4.4036—4	3.5630—4	4.6054—4	3.4204—4	4.2914—4	2.9479—4	3.0948—4	3.2686—4	
χ'^2	9.4	0.152	—0.208	—0.136	—0.200	—0.580	—0.568	—0.984	0.980	1.128	0.404	0.476	0.532	
P %	0.1 – 0.5	3.3	10.0	4.3	6.5	73.8	10.7	117.5	7.7	57.0	2.6	3.6	5.4	
		<0.05	0.5 – 1.0	<0.05	<0.05	>99.95	0.5 – 1.0	>99.95	0.05 – 0.1	>99.95	<0.05	<0.05	<0.05	

For each nominal value the symbols used for calculations have the following meaning:

n = number of measurements; S = Sum of observations $= \sum_{j=1}^{25} x_j$; SS = Sum of squares of observations $= \sum_{j=1}^{25} x_j^2$;

S^2 / n = Sum of observations squared divided by number of observations $= (\sum_{j=1}^{25} x_j)^2/n$;

$SSD = SS - S^2 / n = \sum_{j=1}^{25} (x_j - \bar{x})^2 = \left[\sum_{j=1}^{25} x_j^2 - (\sum_{j=1}^{25} x_j)^2/n\right]$; f = degrees of freedom $= n - 1$;

s^2 = variance $= SSD / f = \left[\sum_{j=1}^{25} x_j^2 - (\sum_{j=1}^{25} x_j)^2/n\right] / f$.

there is a tendency or indication that the measurements indicate a non-normal distribution, appropriate transformations should be made. This is of special importance in Bartlett's test as studies have shown that non-normal distributions materially affect the efficiency of this test.

With the data from Table II and according to the addition theorem for the s^2 distribution, the pooled estimate of σ^2 is

$$s^2 = \frac{\Sigma\ SSD_i}{\Sigma\ f_i} = \frac{256.8040}{312} = 0.823090$$

Using the relationships in (6) and (7) one computes:

$$\sum_{i=1}^{13} \log s_i^2 = 46.2207 - 4(13)$$

$$(1/13)\ \Sigma \log s_i^2 = 3.5554 - 4$$

$$\log s^2 = 3.9154 - 4$$

$$c = 1 + \frac{k + 1}{3kf_o}$$

$$= 1 + \frac{13 + 1}{(3)(13)(24)}$$

$$= 1.0150$$

$$\chi^2 = \frac{2.3026}{c}\left(kf_o\right)\left[\log s^2 - \frac{1}{k}\sum_{i=1}^{k} \log s_i^2\right]$$

$$= \frac{2.3026}{1.0150}(13)(24)[3.9154 - 3.5554]$$

$$= 254.8$$

with $(k-1) = 12$ degrees of freedom.

For 12 degrees of freedom, the chi-square table gives one $\chi^2_{0.99} = 26.2$. As the computed value is far in excess of this value, it is very doubtful if the pooled estimate of σ^2 is justified for an estimate of a common tolerance.

Proceeding to differentiate the various levels of the variance, calculate the $\chi_i'^2$ values according to (8)

$$\chi_i'^2 = \frac{SSD_i}{s^2} = \frac{SSD_i}{0.823090}$$

Then the χ_p^2 intervals corresponding to the values of $\chi_i'^2$ are found in a chi-square table. For example, for $\chi_i'^2 = 9.4$, it is found that $\chi^2_{0.001} = 8.08 < 9.4 < 9.89 = \chi^2_{0.005}$, f = 24. These P-intervals have been entered in Table II. A study of the P percent values obtained indicates the possibility of three differentiations: one group > 99.95 percent, one group between 0.05 percent and 1.0 percent, and another group < 0.05 percent. For each of these groups a separate test will be applied.

In this example, and in the majority of other problems of this nature investigated, the values of χ'^2 fell into rather distinct groups with no overlapping between groups. In the general case, however, there is likely to be some overlapping between the various groups of variances, in which case the procedure is not too clearly defined. A recent theoretical discussion of this problem may be found in Ref. (14). A somewhat less formalized approach might be made in a trial and error procedure by first applying the variance ratio or Cochran's test[9] to the extreme values in a group with approximately the same P-interval, changing the level of significance or the values considered until one forms approximately homogeneous groups, and then verifying this by Bartlett's test.

Considering the group for P > 99.95 percent, the pooled estimate of σ^2 is found as follows:

$$s^2 = \Sigma\, SSD_i / \Sigma\, f_i$$
$$= 204.4640/72 \quad (i = 6, 8, \text{and } 10)$$
$$= 2.839778$$

Using the relationships in (6) and (7) one computes:

$$\Sigma \log s_i^2 = 13.3004 - (4)(3)$$
$$(1/3)\ \Sigma \log s_i^2 = 4.4335 - 4$$
$$\log s^2 = 4.4533 - 4$$
$$c = 1 + \frac{4}{(3)(3)(24)}$$
$$= 1.0185$$
$$\chi^2 = \frac{2.3026}{1.0185}(3)(24)[4.4533 - 4.4335]$$
$$= 3.2$$

For two degrees of freedom, the chi-square table gives one $\chi^2_{0.99} = 9.21$. Since the computed value is less than this, it would be concluded that the differences observed in the three variances is due merely to sampling fluctuations. Therefore, it is possible to use the pooled estimate of the variance to set tolerance limits for nominal values of 50.0, 70.0, and 90.0. If $\pm 3\sigma$ tolerance limits are being used, one would recommend that the tolerance limits for these nominal values be set at $\pm$ 5.0.

Considering next the group for P between 0.05 percent and 1.0 percent, one finds as the pooled estimate of σ^2,

$$s^2 = \Sigma\, SSD_i / \Sigma\, f_i$$
$$= 31.0904/96 \quad (i = 1, 3, 7, \text{and } 9)$$
$$= 0.323858$$

and as before,

$$\Sigma \log s_i^2 = 14.0286 - (4)(4)$$
$$(1/4)\ \Sigma \log s_i^2 = 3.5072 - 4$$
$$\log s^2 = 3.5104 - 4$$
$$c = 1 + \frac{4+1}{(3)(4)(24)}$$
$$= 1.0174$$
$$\chi^2 = \frac{2.3026}{1.0174}(4)(24)[3.5104 - 3.5072]$$
$$= 0.70$$

For three degrees of freedom, the chi-square table gives one $\chi^2_{0.99} = 11.3$. Since the computed value is less than this, the conclusion would be that the variances for nominal values of 0.0, 20.0, 60.0 and 80.0 are equal. Therefore, the tolerances at each of these levels should be set equal, thus increasing the number of observations used for estimating the variance. Using the pooled estimate of $\sigma^2 = 0.323858$, one would compute the estimate of the standard deviation as, $\sigma = 0.569$. If $\pm 3\sigma$ tolerance limits are to be used, one would recommend that a tolerance of $\pm$ 1.7 be assigned to these nominal values.

Next, considering the group of values for which P < 0.05 percent, the pooled estimate of σ^2 is computed as follows:

$$s^2 = (21.2496/144)$$
$$= 0.147567 \quad (i = 2, 4, 5, 11, 12, \text{and } 13)$$

Again using the relationships in (6) and (7), one may compute:

$\chi^2 = 6.7$

For five degrees of freedom, the chi-square table gives one $\chi^2_{0.99} = 15.1$. Since the computed value is less than this, the conclusion is that the variances for nominal values of 10.0, 30.0, 40.0, 100.0, 110.0 and 120.0 are equal. Therefore, the tolerances at each level should be set equal. To see if the variances deviate approximately in a random manner, values of $\chi_i'^2$ are computed from the relationship in (8) by using the new pooled estimate of σ^2, 0.147567; the values of $\chi_i'^2$ and the P percent values corresponding to these values are recorded in Table III.

Although the random nature of the P percent values in Table III may only be subjectively determined, the wide coverage of the P percent values would seem to indicate a random distribution. Consequently, using the pooled estimate of $\sigma^2 = 0.147567$, one would compute the estimate of the standard deviation as $\sigma = 0.384$. If $\pm 3\sigma$ tolerance limits are to be used, the recommendation would be that a tolerance of $\pm$ 1.2 be assigned to the nominal values in Table III.

TABLE III—New Values of $\chi_i'^2$ and P Percent for the Nominal Values Which in Table II had a P Percent Value < 0.05 Percent

Nominal Values	$\chi_i'^2$	P %
10.0	18.6	20 — 30
30.0	24.2	50 — 60
40.0	36.3	90 — 95
100.0	14.4	5 — 10
110.0	20.2	30 — 40
120.0	30.2	80 — 90

Comparison of Observed Tolerance With Theoretical Value (χ^2 Test)

If it is desired to determine if the theoretical tolerance for an individual nominal value is significantly different from a computed tolerance, one may use the test,[7]

$$\chi^2 = fs^2/\sigma^2 \qquad (9)$$

where s^2 is the pooled estimate of σ^2 when this is appropriate from Bartlett's test; and if not, is taken as the computed value of s^2 for the individual nominal value, and

σ^2 is the theoretical variance, and by considering the theoretical tolerance as a 3σ limit this may be computed as $(1/3 \times$ theoretical tolerance value$)^2$.

As an example, the following calculations may be performed for a nominal value of 0.0:

$s^2 = 0.323858$ (which is the pooled estimate of σ^2 for nominal values of 0.0, 20.0, 60.0 and 80.0)

$\sigma^2 = (1/3 \times 3.5)^2 = 1.3611$

$f = n - 1 = 24$

substituting these values into (9);

$$\chi^2 = (24)(0.323858)/1.3611 = 5.71$$

Consulting tables of chi-square with 24 degrees of freedom, it may be verified that this value corresponds to a probability less than 0.005; i.e., the probability that a value smaller than 5.71 would occur by chance is less than 0.005. Therefore at the one percent level of significance, the conclusion would be that the computed tolerance is significantly smaller than the theoretical tolerance.

Analysis of Variance for Heterogeneous Variances

For a substitute of the control chart for averages, the analysis of variance techniques may be used to determine if the mean errors for the various nominal values may be considered as fluctuating in a random manner. As the operation of the equipment is very likely to cover the whole range of nominal values, it is desired to have a test criterion which provides an evaluation of the overall performance of the equipment.

The initial hypothesis (H_0) will be that the mean error at level one is equal to the mean error at level 2 . . . . . is equal to the mean error at level k; i.e $\mu_1 = \mu_2 = \ldots = \mu_k$.

If the variances had been shown to be homogeneous, one could apply the usual analysis of variance techniques to determine if the mean errors are the same for different nominal values. However, since Bartlett's test has indicated the presence of heterogeneous variances, a test which is not exact—but in many cases useful—should be used to determine if the mean errors are identical. Using Snedecor's approximate method,[16] the procedure is to calculate a pair of weighted mean squares, then test their ratio against the F-distribution. For this test analyze the mean errors as deviations from nominal values; these are the values recorded as $\bar{X}$ in Table II. The calculations are outlined in Table IV.

F′ is distributed approximately as the F-distribution with f_1 and f_2 degrees of freedom. In Table IV, F′ was calculated to be 17.807. Referring to an F table, it may be verified that the probability is less than 0.005 of obtaining this large a value of F′ if the initial hypothesis is true. Therefore, the hypothesis that the mean errors are distributed in a random manner around the weighted mean is rejected.

Comparison of Observed Nominal Values With Theoretical Values (t-Test)

As the mean errors may not be regarded as being the same for different nominal values, a test of significance[9] may be made to determine which mean errors—or observed nominal values—are significantly different from the nominal values specified by design and/or theoretical specifications before the production of this product. This may be readily accomplished from the calculations in Table II by computing,

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} \qquad (10)$$

where

μ_0 = theoretical nominal value

$\bar{x}$ = computed average or nominal value

s = the square root of the pooled estimate of σ^2 when this is justified by Bartlett's test, otherwise use the computed value for an individual nominal value.

For example, with a nominal value of 0.0:

$$\bar{x} = 0.636$$

$$\mu_0 = 0.0$$

$$s = \sqrt{0.323858} = 0.569$$

$$\sqrt{n} = \sqrt{25} = 5$$

substituting these values in (10),

$$t = \frac{0.636 - 0.0}{0.569/5} = 5.589$$

For 24 degrees of freedom the tabular value of t at the one percent level of significance is 2.797. Since the computed t value is larger than this, the conclusion is that the observed nominal value is significantly larger than the theoretical nominal value.

TABLE IV—Calculation for Test of H_0: $\mu_i = \mu$ if Variances are Heterogeneous
(Test results from Table I)

[1] Size of sample n	[2] Mean Error $\bar{x}_i$	[3] Variance s_i^2	[4] Weight $w_i = n_i/s_i^2$	[5] Deviation $\bar{x}_i - \bar{x}_w$	[6] $(\bar{x}_i - \bar{x}_w)^2$ = [5]^2	[7] $w_i / \Sigma w_i$ = [4] / Σ [4]	[8] $(1 - w_i / \Sigma w_i)^2$ = (1 − [7])^2	[9] $(1 - w_i / \Sigma w_i)^2 / n - 1$ = [8] / ([1] − 1)
25	0.636	0.3232	77.35	0.389	0.151321	0.053044	0.896727	0.0374
25	0.152	0.1143	218.72	−0.095	0.009025	0.149992	0.722514	0.0301
25	−0.208	0.3433	72.82	−0.455	0.207025	0.049938	0.902618	0.0376
25	−0.136	0.1491	167.67	−0.383	0.146689	0.114983	0.783255	0.0326
25	−0.200	0.2233	111.96	−0.447	0.199809	0.076779	0.852337	0.0355
25	−0.580	2.5325	9.87	−0.827	0.683929	0.006769	0.986508	0.0411
25	−0.568	0.3656	68.38	−0.815	0.664225	0.046893	0.908413	0.0379
25	−0.984	4.0306	6.20	−1.231	1.515361	0.004252	0.991514	0.0413
25	0.980	0.2633	94.95	0.733	0.537289	0.065114	0.874012	0.0364
25	1.128	1.9563	12.78	0.881	0.776161	0.008764	0.982549	0.0409
25	0.404	0.0887	281.85	0.157	0.024649	0.193285	0.650789	0.0271
25	0.476	0.1244	200.96	0.229	0.052441	0.137813	0.743366	0.0310
25	0.532	0.1856	134.70	0.285	0.081225	0.092374	0.823785	0.0343
k = 13			Σ[4] = 1458.21					Σ [9] = 0.4632

Weighted mean: $\bar{x}_w = \frac{\Sigma [2][4]}{\Sigma [4]} = \frac{(0.636)(77.35) + \ldots + (0.532)(134.70)}{1458.21} = 0.247$

Weighted sum of squares: $\Sigma [4][6] = (77.35)(.151321) + \ldots + (134.70)(.081225) = 226.6473$

$$F' = \frac{\Sigma [4][6]/k - 1}{1 + \frac{2(k-2)}{k^2-1} \Sigma [9]} = \frac{226.6473/12}{1 + \frac{22}{168}(0.4632)} = 17.807$$

$$f_1 = k - 1 = 12 \quad f_2 = \frac{1}{\frac{3}{k^2-1} \Sigma [9]} = \frac{1}{\frac{3}{168}(0.4632)} = 120.9$$

Conclusions

In Table V is a summary of the specifications computed in this analysis and the theoretical specifications specified by design and/or theoretical studies. Several discrepancies may be noted between theoretical specifications and the specifications computed.

TABLE V—Comparison of Theoretical and Computed Specifications

Nominal Values		Tolerances	
Theoretical	Computed	Theoretical	Computed
0.0	0.636*	3.5	1.7*
10.0	10.152	1.9	1.2*
20.0	19.792	2.0	1.7
30.0	29.864	1.1	1.2
40.0	39.800	1.5	1.2
50.0	49.420	3.9	5.0
60.0	59.432*	2.6	1.7*
70.0	69.016*	7.7	5.0*
80.0	80.980*	2.6	1.7*
90.0	91.128*	3.9	5.0
100.0	100.404*	1.5	1.2
110.0	110.476*	1.1	1.2
120.0	120.532*	2.0	1.2*

*Values are significantly different from theoretical values.

1. Bartlett's test has indicated differences between the tolerances which were theoretically to have common tolerances for different nominal values and those which were computed from production test results to have common tolerances. For example, the tolerance for nominal values of 30.0 and 110.0 was to have a common value of 1.1; but according to Bartlett's test, the nominal values of 10.0, 30.0, 40.0, 100.0, 110.0 and 120.0 had a common tolerance of 1.2.

2. According to the chi-square test for a comparison of observed and theoretical tolerances, six of the 13 computed tolerance values were significantly different from the theoretical tolerances.

3. By means of the analysis of variance for heterogeneous variance, the conclusion is that the 13 mean errors are not distributed in a random manner around a central mean value.

4. Testing the differences between the computed and theoretical nominal values, one finds that eight out of 13 of the computed nominal values are significantly different from the theoretical nominal value.

From the statistician's point of view, the computed specifications would be a better guarantee for the quality of any product. Presumably many of the departures from theoretical specifications could be attributed to assignable causes of variation in the design or production of the equipment, and further studies and corrective actions would alleviate the departures from theoretical specifications.

At this point, however, it may be well to consider the statistician's role in the quality evaluation for a product. The statistician serves in a capacity akin to that of a counsel for defense in a trial. He may serve well to uphold the logic and theory behind his analysis, but a verdict as to the usefulness and practicality of any statistical analysis must rest in the hands of the jury; the jury in this case is the personnel in the various departments of engineering, management, and production.

Acknowledgment

Grateful acknowledgment is hereby made to the referee who reviewed the initial version of this article and made numerous helpful and constructive suggestions which have been incorporated in the published article.

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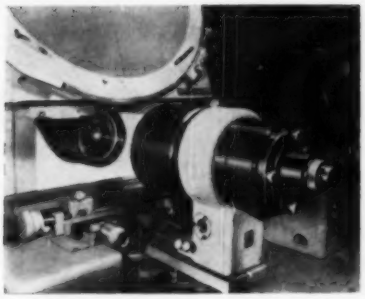
What's New?

ROY A. WYLIE, *Editor*
Ampex Corporation



P-1-5—The Optical Comparator Division of Jones & Lamson Machine Company, announces the introduction of a new 5 magnification lens system with a 6 inch aperture, free from measurable distortion. The new J & L lens is especially useful in applications which require the precise measurement of large areas. It permits great latitude of use, due to its extremely sharp definition and freedom from distortion. It is easily installed in all Jones & Lamson Comparators that are equipped for five magnifications. Detailed information is available from the field representative or through the *Industrial Quality Control* "Product Education Service," page 37, this issue.

★ ★ ★

P-11-8—A calibrated Sphere Gap Assembly for precision high voltage measurements has just been added to the line of electrical measuring instruments manufactured by Associated Research, Inc. The model 8526 Sphere Gap Assembly includes a sphere gap and current limiting resistors mounted on an insulating base. Spacing of the two 6.25 cm. spheres is controlled by a micrometer adjustment calibrated in thousandths of an inch. Measurements accurate to plus or minus 3% may be made of d-c potentials and crests of a-c potentials at commercial power frequencies, up to 120,000 v. A current limiting resistor assembly is incorporated to minimize sphere pitting and to suppress oscillation.

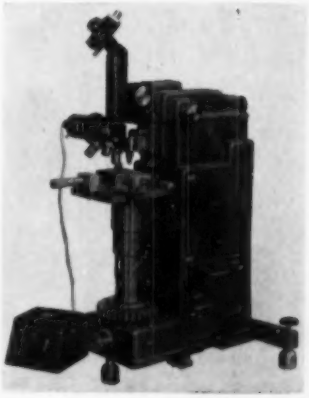
★ ★ ★

P-11-9—The first of a line of environmental chambers, that will test products and materials while undergoing radiation exposure, has recently been developed by Cincinnati Sub Zero Products. The three cubic foot test chamber has an adjustable temperature range from + 180 degrees F. to -80 degrees F. Altitude can be controlled from sea level to 100,000 feet, in fifteen minutes time. A steam vapor generator provides up to 100% relative humidity in the chamber. The water supply reservoir is mounted directly on the unit so that, except for the electrical service, it is completely portable on four 6 inch casters. Radiation in the chamber is accomplished by a 1 inch diameter nonmetallic tube that penetrates through the chamber and extends 6 inches on each side. A capsule of radioactive material is inserted in the tube for the test. The chamber can be used with or without the capsule in the tube. Other special accessories of the unit include program controllers for wet and dry bulb temperatures and absolute pressure. The chamber has interior illumination, a special 2 inch entrance port, and an 8 inch by 8 inch Multipane frostproof observation window. External dimensions are 66 inches high, 54 inches long, and 28 inches wide. Similar equipment with larger chamber capacities can be designed.

★ ★ ★

P-12-7—The new Sens-OAR-chrome is a compact, lightweight electronic color monitor and control unit, capable of displaying information revealing variations in hue (principal observed wavelength) and in intensity (at that wavelength) of light received from test samples. The instrument also provides control output of 0.25 watts or greater power, for controlling processes so as to assure that product will closely adhere to predetermined standards of color, both as to hue and saturation of pigment. The initial model (Model I B I) is intended primarily for analysis and control of light transmitted by liquids, sols, gels, or solid transparent or translucent objects. Operation is relatively simple. It employs the OAR system (Optical Automatic Ranging) which spreads received light into a spectral array in which each wavelength is brought to a different focus. A vibrating sensor, composed of a plurality of photo-sensitive elements continuously samples this array. The sensor's current output provides positive servo commands which move the optical system so that it always restores the focal point of the principal observed wavelength to the midpoint of the oscillating sensor's travels. The servo movements effecting these adjustments of the optical system, are converted into variations in an output current within a range of 40 volts. This current, displayed on a voltmeter, sensitively indicates minute alterations of hue; and it is also available as a control current of at least 0.25 watts power for any processing controls required to restore predetermined color characteristics to product. Also, the electromotive output of the photo-cell system is indicative of the intensity of radiation received at the principal observed wavelength. Suitably amplified and displayed on another voltmeter with 40 volts range, this current reveals variations in pigment saturation. This control current, too, is available with at least 0.25 watts of power for any desired processing adjustments to maintain predetermined color saturation or density in the product. Weight of the unit is 40 pounds complete with light source. Size is 10 by 12 by 30 inches. The entire instrument is enclosed in a metal case with carrying handle. Two meters are supplied, each displaying voltage variations over a 40 volt range. Sens-OAR-chrome's normal response speed is 2 seconds. This rate however, may be adjusted widely to match durations of processing cycles to be controlled. Where very speedy response is needed variations may be perceived visually on the trace of an oscilloscope on the hue output circuit—within 1/120th of 1 second. Stability when observing unchanging samples, is within 0.25 volts during hours of continuous operation. The basic photo-cell system has a pattern of color-sensitivity akin to that of the human eye, with marked additional responsiveness in the blue-green spectral area between 500 and 520 millimicrons wavelength. Supplemented by a suitable optical filter, Sens-OAR-chrome has provided on its hue output circuit voltage changes as large as 12 volts, in response to shifts of less than 12 millimicrons in the principal observed wavelength.

★ ★ ★



P-1-7—A new Micro Hardness Tester, with a vertical capacity of 8 inches has been announced by the Torsion Balance Company. The Kentron Micro Hardness Tester applies dead weight loads from 1 to 1000 grams. (Additional weights for applying heavier loads up to 10,000 grams can be furnished as optional equipment.) Known as the Model AK 8, this equipment is basically a quality control instrument but has the same accuracy as the Model AK, which is a standard research instrument used in metallurgical laboratories. This new 8 inch Micro Hardness Tester is especially designed to test unmounted parts so they can be returned to production or the stock bin. It can also be used to test mounted specimens, small parts, sheet metal, wire, etc.

(Continued on page 24)

Quality Control ~ ~ **the GOLD**

14th Annual ASQC Conven

The Golden Gate Bridge, cable cars, and Chinatown help make San Francisco a fabulous setting for the May 24-26 convention of your American Society for Quality Control.

The meeting will feature 46 speakers, six panel discussions, many exhibits, and an opening talk by the new president of the National Association of Manufacturers, Rudolph F. Bannow, Bridgeport Connecticut, industrialist.

Immediately following the May 24-26 Convention, a Mid-Pacific Quality Control Conference will be held in Honolulu (May 27-June 2).

The Convention will be held at the Sheraton-Palace Hotel, a successor to the original Palace Hotel, which was destroyed by fire following the 1906 earthquake. The heart of the hotel is its garden court.

Reservations for the Convention and/or the Hawaiian Conference may be made now by contacting

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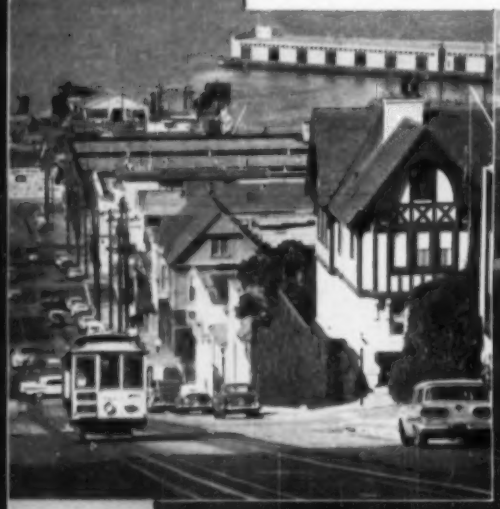

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(see opposite page →)

(Continued from page 19)

P-12-1—A low-cost leak standard for calibrating and checking operation of halogen-sensitive leak detectors is now available from General Electric. A small portable unit weighing about three pounds, it provides an adjustable reference leak of known rate. In operation, it releases refrigerant gas through a tiny capillary tube at manually controlled rates—indicated on a circular dial—ranging up to about three ounces a year. Use of the standard provides a reference against which the size of leaks may be accurately determined. Users may now establish leak rate specifications and realize savings by repairing only those leaks large enough to cause malfunction of their equipment. In addition, the leak detector sensitive elements are often replaced before they are expended, for lack of an accurate reference against which to test them. Periodic checks using the leak standard will prevent discarding elements until they have reached the end of their useful life. The device which requires no power supply, is suitable for calibrating leak detectors used for locating leaks of R-12, R-22 or R-114 refrigerants. It contains sufficient gas for more than a year of normal use and can be refilled by the user at a cost of less than fifty cents. The leak standard is intended for use with Types H, H-1, H-2, H-3, H-5, H-6 leak detectors.

★ ★ ★

P-1-12—A new type of precision granite surface plate, designed for rapid three-dimensional checking is now available from the Herman Stone Company. This line of surface plates will speed up checking operations by providing accurate angles that allow two or three sides of a precision part to be checked simultaneously. Inside square plates may be produced with one or two vertical sides. All angles formed by the sides and the base are held to an accuracy of 90 degrees ± 3 seconds. These plates are manufactured of quartz granite to assure long life and dimensional stability.

★ ★ ★

P-12-3—Their new Model T207 Michrom Bridge (Bonding Meter) has just been announced by Avtron Manufacturing, Inc. Designed to provide a safe method of measuring low resistances in "hazard" areas, the T207 gives precision measurements on and around aircraft, fuel tanks, and fuel cells with no danger of explosion. Range of 1 micro-ohm to 1 ohm, or 1 million to 1, makes the unit extremely versatile for measuring grounds, bonds, and connection resistances. The Model T207 is a self-contained a-c resistance bridge; all operating power comes from a battery pack of flashlight cells. Maximum voltage that can be obtained outside the case is less than .055 volts a-c. The power supply reduces the voltage so low on any current coming through the leads or probes that ignition of flammable gases or fluids is impossible. The unit has a vapor-tight housing, with all joints sealed and gasketed to prevent ignition of gases or liquids.

P-1-3—A Hydroion Meter designed for conveniently measuring the specific conductance of a solution in locations where electric power is not available is now being marketed. Easy to handle and read, this portable conductivity tester is particularly suitable for testing liquids in refineries, oil drilling operations, chemical processing laboratories, electronic, aircraft and plating firms, or wherever the need exists for quick and accurate temporary measurements. The Carma 72734 Meter is battery operated and reads PPM in saline or other solutions. It has a temperature compensating adjustment and selector to read either directly or PPM x 10. Lower cost plug-in AC instruments reading Micro-Mohs and PPM simultaneously are also available. Meter ranges are from 0 to 100,000 PPM witih increments down to 0.5 PPM. Weight is 1½ lbs. Price is $130.00.

★ ★ ★

P-1-9—A new instrument designed to meet specific autocollimation requirements in product quality control work has been developed by Tinsley Laboratories, Inc. The Tinsley Autocollimator is designed to replace expensive alignment telescopes in those applications where the telescope is being used primarily for autocollimation. The new autocollimator is priced considerably less, but performs dependably and accurately. The Tinsley Autocollimator features an interchangeable light source and eyepiece for viewing from end or side. It permits comfortable viewing even for those who wear eyeglasses. Designed to fit standard fixtures, the barrel diameter is held to the tolerance of the standard diameter for optical tooling, NAS 900 standard 2.2498/2.2493. The autocollimator is compact and light weight with an overall length of 14⅞ inches when the lamp is in the line of sight position. It is constructed of corrosive-resistant material and is capable of reading precise angles to 10 seconds. It has a power of 20 and a total useful field of 4 degrees. Lenses are coated for low reflection. Its standard reticle has a 5mm 0.02 line spacing with bright line cross target. Tinsley also manufactures custom reticles.

P-12-6—An electronic instrument, about the size of a machinist's toolbox but with the ability to make highly accurate spot checks of small parts during production runs has been announced by RCA. The RCA Limit Signaling Comparator operates on radio frequency and gives instantaneous response. The instrument is ideal for checking materials as they are received from a supplier, spot checking during production runs, or post process gaging. The RCA Comparator consists of a master control, the necessary electronic circuits and a power supply. The gage head can be adjusted so that the desired size of the part under examination is indicated on the meter as the acceptable standard. Nine different gage heads are available, permitting direct readings ranging from .000050 inches to .001 inches per dimension. The unit can be installed in a fixed position or carried from job to job. A standard RCA air electronic kit makes possible use of the air-gaging method. High, low and acceptable limit lights on the meter panel reduce operator fatigue and increase the accuracy of high speed gaging.

★ ★ ★

P-1-1—ACS Tapes, Inc. has expanded its line of self-sticking tapes to include plant layout symbols, newspaper and advertising border tapes, special reference design, etc. all pre-printed on tape. To further assist the engineer, draftsman, artist, layout man, statistician, etc., ACS Tapes is introducing a selection of 15 colored, matte surface tapes that are completely non-reflecting and may be written on with pen, pencil, or most any standard marking device. These new tapes are available in seven ACS standard widths: 1/32 inch, 1/16 inch, 1/8 inch, 1/4 inch, 1/2 inch, 3/4 inch, and 1 inch. They may be purchased from the local ACS dealer. The manufacturer will supply further information and free samples.

★ ★ ★

P-1-2—A new method of inspecting and recording gage block accuracies has been developed for Webber Gage Company, Cleveland, Ohio. The new method, which incorporates specially designed electronic equipment, eliminates human error in the calibration of gage blocks. It also speeds up gage block inspection service so that blocks sent in for inspection can be returned to owners in a very short time. The new electronic equipment automatically records gage block sizes on a special certificate form. It shows deviation from marked size of each block to the 6th decimal place, and "flags" any blocks which are worn enough to require replacement in accordance with Federal Specifications. The equipment consists of a high precision electronic comparator which measures gage blocks to an accuracy of one millionth of the new International Inch; and a digital voltmeter, which shows gage block size visually, and automatically sends impulses to an electric typewriter. The typewriter then automatically records correct sizes on the Webber Certificate.

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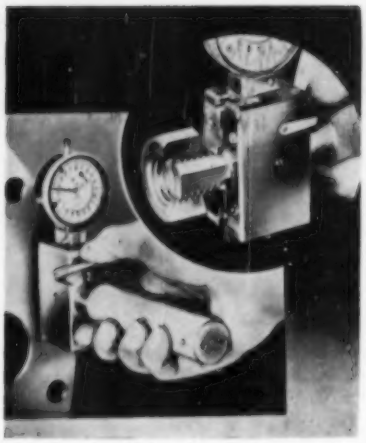


P-1-10—The Mahr Gage Company, Inc. is introducing a Dial Thread Plug Gage which will speed up the inspection of internal threads and will perform the GO and NO GO inspection in one operation. This measuring instrument employs three measuring jaws one of which is retractable between the other two. In this way the jaws can be inserted into the thread to be checked without any threading in and out. The measuring jaws expand under spring action and engage the thread along its entire length. The two fixed lower jaws center the instrument in the threaded bore, whereas the upper movable jaw transfers its movement to the indicator. After setting the indicator to zero with a ring gage the instrument is inserted and the measurement of the female thread may be read immediately on the dial and its tolerance position noted. The measuring segments are easily and quickly interchangeable. One set of three measuring segments is required for each type and thread size. There is little wear on the segments during the measuring process. Four sizes cover a range from 0.080 inches to 4.800 inches.

★ ★ ★

P-1-8—RCA is now offering a complete line of standard electronic modules which can be easily assembled into semi or completely automatic high speed inspection systems for simple or complex dimensional measurements. The modules are suitable for various applications such as automatic hardness testing, self-compensating grinder controls, valve and spring testing, as well as in the inspection of ball and roller bearings, piston and piston pins, and crankshafts. Systems built with these modules offer high repeatability, reliability, flexibility, immediate response and accuracies in the millionths. There are five basic units. (1) the AGMC master gage control, which includes a gage head, is the primary building block of the system. It transforms the electrical changes caused by the displacement of the gage tip into a directly usable signal requiring no amplification. (2) The ATM Thyratron Unit is the electronic switch which provides a directly usable limit signal. (3) The APS Power Supply is a standard unit, only one of which is required with up to five thyratrons. (4) The DC-7 Difference Computer subtracts measurements from two AGMC units and provides a reject signal. It is used for calculating taper, parallelism, squareness and similar dimensional characteristics. (5) The SC-7 Sum Computer adds the signals from two AGMC units and is used to calculate overall dimensions determined by the individual measurement of two segments of the overall dimension. These building block units can be used in a number of different combinations to solve most complex measurement problems, as well as to actuate segregating, marking and stamping devices. They can be supplied individually, complete with connector plugs for mounting in the customer's cabinet or as a completely integrated system including a wiring harness and cabinet. A selection of nine gage heads with sensitivities that provide full scale readings of 0.005 inches to 0.020 inches are available with the AGMC unit.

★ ★ ★

P-12-2—Announcement has been made of the availability of the new Rotary Proficorder, a mechanical electronic instrument for research, experiment and production. It provides a permanent, magnified chart record of the shape, height and spacing of all surface irregularities including pits, flaws, waves, roundness, waviness, roughness and total profiles. The Rotary Proficorder consists of three basic units: Tracer, Pilotor and Amplicorder. The Tracer is a differential transformer type transducer that transforms the physical displacements of the stylus into electrical charges which are fed into the Amplicorder and translated on to graph paper for study and permanent record keeping. A diamond stylus of suitably small tip radius rides lightly on the work being measured. Tracing range on O.D.'s is from $\frac{1}{32}$ inch to 8 inches. On I.D.'s from $\frac{1}{8}$ inch to 8 inches. The Pilotor supports the Tracer and Tracer Adaptor. It also provides the circular tracing motion required to measure around surfaces of rotation. The height adjustment of the Pilotor is 6 inches. Its reference surface is a precision spindle with accuracy to .000003 inch. The Amplicorder contains the electronic system and the chart recorder. It also provides a mounting space for the pilotor.

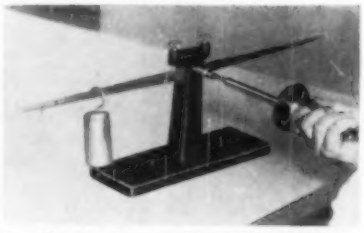
★ ★ ★

P-12-8—A high energy microwave linear accelerator, developed by High Voltage Engineering Corporation, generates intense x-ray outputs for deep-penetrating radiography. Available in two models, rated at 8 and 15 million electron volts, the new LR series permits precise radiographic examination of thick sections of steel, complex electromechanical assemblies, or solid rocket propellants at speeds ten times faster than conventional equipment. The High Voltage Model LR-8 accelerator offers a dual x-ray output of 6000 r/minute from a 5 mm focal spot and, for greater precision, 1500 r/minute from a 1 mm focal spot, with intensities measured at a 1 meter distance from the source. Electron energies are continuously variable from 2-8 Mev. At the maximum, the intense x-ray output of the LR-8 permits shorter exposure times for thick sections by at least a factor of ten compared with other high energy radiographic means. The Model LR-15 offers an x-ray output of 3000 r/minute at 1 meter distance from a 1 mm focal spot. Its energy range is continuously variable from 3-15 Mev. It was developed after intensive study of the requirements of the rocket industry and is designed for radiographic inspection of solid fuels and other bulky materials. The compact design of the new machine permits a variety of mounting arrangements. They can be permanently installed by means of an overhead crane suspension mount or can be truck-mounted to provide the greatest flexibility at the point of use. Price of either machine is approximately $150,000 plus mounting.

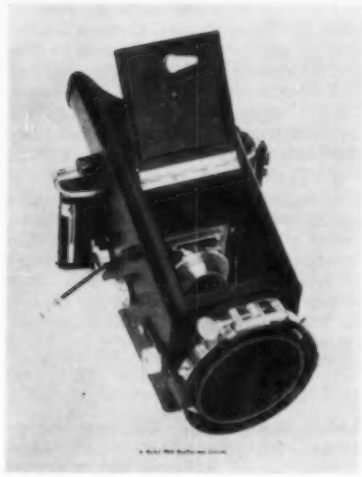
★ ★ ★

P-12-4—An accelerometer sensitivity standardizer called the Dial-A-Gain converts all accelerometer sensitivities to a convenient 1 Volt/g, allowing direct reading of acceleration on any VTVM. The Dial-A-Gain includes a cathode follower input and a precision amplifier with a continuously variable gain control dial, calibrated directly in accelerometer sensitivities. The Dial-A-Gain eliminates external cathode followers normally used and is available with single or multiple inputs.

★ ★ ★



P-1-4—A table size Dead Weight Beam Torque Tester for rapidly checking calibration of various torque tools ranging from 3 inch-ounces to 150 foot-pounds has been put on the market by Apco Mossberg Company. The tester utilizes the most efficient method of testing torque—dead weight. Compact and versatile, the tool is used for testing calibration of torque screwdrivers and wrenches, including the deflecting beam type torque wrench, rigid frame type, T-handle and micro-set types, and other torque tools and devices. Friction in the unit is virtually eliminated through the use of ball bearing pillow blocks. Weighing only 5½ lbs. and with two holes in the base for mounting on testing bench, the Dead Weight Beam Torque Tester is a balanced unit for delivering accurate torque readings necessary for recalibration of torque tools. The aluminum, chrome-plated balancing beam is 24 inches long, pivoted at the center, and graduated in increments of 1 inch. Removable square adapter fits tools with ¼ inch or ⅜ inch drives.



P-1-6—A convenient, easy-to-use oscilloscope camera which records full-sized oscilloscope patterns without distortion on Polaroid Land film is now available from Hewlett-Packard Company. The camera, Model 196A, uses a standard camera bellows to eliminate light leakage. Its object to image size ratio is 1 to 0.9 to show a full 10 cm graticule width. Lens adjustments may be made without removing the camera from the scope. Model 196A simplifies multiple exposure procedures since a convenient knob moves the lens through 11 detented positions while the camera back remains fixed. The stationary camera back also simplifies tab pulling. The new camera is rugged, compact and weighs only 9 lbs. It is equipped with a special "quick-lock" tab for easy, one-hand mounting on the scope. While making an exposure, the operator can observe the pattern with both eyes. The Model 196A Oscilloscope Camera is priced at $425.00.

★ ★ ★

P-12-5—A new fixture for rapid testing of torsion springs features interchangeable arbors and 360° protractor. Additional arbors to fit special springs can be obtained. This tester embodies a torque wrench as a sensing element, allowing various ranges from inch-grams up to 100 inch pounds. The basic unit can also be used for direct torque testing without modification. The unit is adaptable to the testing and setting of small torque screw drivers. Most laboratory and line testing can be done without mounting the fixture to a bench.

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P-1-11—More than 500 tests for particulate contamination of oils, fuels, water, cleaning fluids and other liquids can be carried out with the contents of a new kit developed by the Millipore Filter Corp. The Contamination Analysis Kit contains everything needed to conduct the filtrations of liquid samples and to prepare the Millipore filter for subsequent examination with existing laboratory microscopy facilities. Particles screened from fluids lie directon the surface of the Millipore filter where they may be easily examined or counted. The Kit includes apparatus such as a filter holder, vacuum flask, vacuum pump and petri dishes; grid-marked Millipore filters; and 144 2 inch by 3 inch microscope slides. Particle size distribution analysis with the Millipore filter forms the basis of many industrial and military standards for fluid cleanliness such as the S.A.E. proposed ARP-598 Procedure for the Determination of Particulate Contamination of Hydraulic Fluids by the Particle Count Method; and the A.S.T.M. Proposed Method of Test for the Determination of Particulate Matter in Hydrocarbons. The contamination Analysis Kit may be used for a variety of other analytical determinations such as filterability measurements on specific fluids, gravimetric analysis, radichemical analysis, colorimetric testing and microchemical analyses.

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P-12-9—The Model 8516 Pilotal Ohmmeter just introduced by Associated Research, Inc. provides precision automatic production testing of components and assemblies within preset resistance ranges. This precision automatic limits bridge indicates on pilot lamps whether resistance is less than, within, or greater than the predetermined limit. The standard model 8516 covers a range of 3.75 to 4.00 ohms. It may be supplied to cover any desired limits between resistance ranges of 0.1 and 1 million ohms or higher. Accuracy on the standard instrument is better than 0.05 ohms. Operation requires only connection to leads of the item being tested. The red pilot light glows if the resistance is below the lower limit, the green lamp glows if the resistance is within limits, and the amber light indicates resistance above the upper limit. These indicators may be used to control external mechanical rejection circuits for fully automated production testing. The Model 8516 operates from 115 v, 50-60 c line and has very low voltage at test terminals for operator safety. Built in calibration controls allow accurate and convenient checking of high and low resistance limits.

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P-12-10—A vacuum gage of new design the "Open End McLeod Gauge", eliminating capillary contamination and providing easier, more accurate readings, has been developed and introduced by the Manostat Corporation. The new gauge does away with the closed end capillary, thereby eliminating contamination. It dispenses with the comparison capillary and its possibility of compounded error in measurement. One direct reading manometer replaces the former two tubes, while a rubber "O" ring vacuum sealed piston operating in a precision bore tube allows micrometric adjustment of the mercury meniscus. The gas tight piston can be raised by a sliding action which in turn raises the mercury level in the reservoir. As the mercury level passes the connecting tube, it traps a given amount of gas from the system and compresses it into the bulb between two mercury columns. At this point, the threads of the piston knob engage and the mercury meniscus can be micrometrically adjusted to the ring marking the exact volume of compression. The mercury meniscus in the calibrated manometer tube then reads the absolute pressure of the gas in the system.

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P-12-11—A portable, compact and easy-to-adjust dial indicating gage, complete with .0005 inches indicator for checking internal grooves has been announced by Boice Gages, Inc. The unit which may readily be operated by unskilled personnel, is well suited for patrol inspection, at-the-machine checking, or with a comparator stand may be employed for bench inspection. The Boice Groove Gage has a range of .750 minimum to 3 inches maximum diameter, a ⅛ inch maximum groove depth and 3/32 minimum groove width.

New Literature Available

The Department of the Air Force has just published a "Table of Probabilities for use in Exploratory Sampling." The table presents the probabilities that a particular sample will contain one or more items with a designated characteristic if the sample is drawn at random from a universe which contains a specified number of items with this characteristic.

It is arranged in 47 convenient universe sizes ranging from 100 to 200,000. The increments are 100's up to 1,000; 200's up to 3,000; 1000's up to 15,000; 5000's up to 40,000; 10,000's up to 100,000, and 25,000's up to 200,000.

One universe size is presented per page with up to 56 selected sample sizes ranging from 5 to 2,000 items. For each universe and sample size combination, the number of "error items," ranging from 1 to 2,000 is presented as appropriate. The probabilities are presented as percentages.

The tables are quite useful for a number of applications, however, the two direct applications are these: for each specified universe size, the table gives the probabilities of finding at least one error item in a given sample size, for different values of the number of error items in the universe. Or if the number of error items in the universe is fixed, it gives the probabilities of finding at least one error item in different sample sizes.

The Air Force plans to make the tables available shortly. Requests should be directed to: Major General W. P. Farnsworth, AFAUD, Dept. of the Air Force, Washington 25, D. C.

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L-2-1—Radio Corporation of America is now offering a new brochure on its electronic gaging systems. A complete description of such systems and of each of the modules comprising them is given and typical applications are shown.

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L-2-2—Special emphasis has been placed on electronic equipment for industry, with the new 1960 catalog just

released by Allied Radio Corporation. Allied's new 528-page catalog includes 232 pages in rotogravure and 4-color covers. It lists over 40,000 items, such as parts and equipment for industrial maintenance, research and production requirements.

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L-2-3—A booklet entitled Polyvariable Experimentation, a Powerful Statistical Tool for Experimentation and Control by F. E. Satterthwaite and Dorian Shainin is available to ASQC members from Statistical Engineering Institute, 8 Fuller Road, Wellesley, Massachusetts.

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L-9-7—A revision of the 1957 Environmental Requirements Guide for Electronic Component Parts, published by the Department of Defense for use by Armed Forces technologists, has just been released to the public through the Office of Technical Services, U. S. Department of Commerce. In addition to the R & D environmental design requirements for current and future electronics planning, the guide also reviews appropriate test procedures. Information presented in the original guide, published in 1957, is brought up to date.

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L-12-1—The Santa Barbara Division, Curtiss-Wright Corp., has issued an illustrated catalog sheet describing in detail the features and general specifications of "Demon", Curtiss-Wright's new universal digital automatic checkout equipment. The equipment, when used with appropriate signal sources, can handle a wide variety of checkout problems of varying degree and complexity.

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L-12-2—A four-page folder which describes the Barden SmoothRator, an electronic tester that predicts performance qualities of oil-lubricated precision ball bearings up to 1 inch O.D., is available from The Barden Corporation. By revealing vibrational characteristics of bearings, the SmoothRator detects performance aspects not measurable by other types of testers.

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L-12-3—Industrial Nucleonics' new bulletin "Accuray on-Stream Instrumentation No. PI-959 is a twelve page brochure containing information on all process industry measurement and control equipment manufactured by this company.

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L-12-4—A one-page brochure now available, discusses the additions to the SIE line. It includes photographs of and specifications for the model R-3 transistorized voltmeter, model N-1 transistorized signal generator, model T-1 vibration meter, model R-2 vacuum-tube voltmeter, ARP audio response plotter, model D-3C DC amplifier, and model K-1 microsource.

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L-1-1—Dressen-Barnes Corp. has prepared a four-page report covering a step by step procedure with appropriate illustrations, designed to improve the quality of solder joints. Several years in the making, this procedure is the one used by Dressen-Barnes' production and quality control departments to increase the reliability of electronic circuitry. Various types of solder joints are shown with detailed instructions for proper solder of the many common joints encountered in electronic circuitry.

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L-1-2—The Society for Nondestructive Testing has announced the completion of the Nondestructive Testing Handbook. This, the first nondestructive testing handbook, has been prepared under the auspices of the Society Editor, Robert C. McMaster with an Editorial Board of 106 contributing and consulting editors. They have in two volumes covered the principles and background of twenty-four various methods. These volumes will be practical handbooks for research and engineering groups, manufacturing and quality control personnel as well as those working in industrial maintenance fields.

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L-1-3—A new four-page three color brochure, illustrating representative groupings of the complete line of Slocomb micrometers is available from the manufacturer. Pricing information is provided on a separate insert sheet. Examples of standard micrometer calipers ranging from 1 inch through 60 inches are shown along with illustrations of many "special" micrometers, including the snap gage, air foil, sheet metal and others.

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L-1-4—Technical Information Corporation announces the publication of a 28-page book containing complete specifications and prices of 152 signal generators manufactured by 30 American and foreign companies. Specifications are arranged in tabular form using common headings. Instruments are arranged according to upper frequency range and run from 70 kc to 40 kmc. In addition, all instruments are indexed by manufacturer and function. Copies are available at $2.00.

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L-1-5—The new M-S-A Process Refractometer, designed for measurement and control of liquid organic and inorganic streams, is described in a bulletin just issued by Mine Safety Appliances Company, Pittsburgh. The illustrated release provides complete details on application of the Refractometer to a variety of industrial problems, including the control of either stream or batch processes, the measurement and control of product quality, and other applications requiring rapid, accurate analysis.

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L-1-6—A new descriptive folder from Industrial Gauges, Daystrom, Inc. details equipment and operating principles of a new non-contact radiation-operated gauge which measures and records width of hot strip traveling at speeds as fast as 2,000 feet per minute.

L-1-8—A new twenty-four page, two-color brochure entitled Gamma Radiography, has just been published by The Budd Company's Nuclear Systems Division. Contents of the illustrated booklet include: gamma radiography—its background, applications, advantages, safety and definitions; Budd Nuclear Systems services, selection of sources and equipment for gamma radiography; methods of exposure—beam; internal and panoramic. The brochure also contains sections devoted to typical radiographs and what they show, a complete list and description of Budd radiography equipment and related radiography equipment and services.

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L-1-9—Bulletin GEZ-2939 describes operating principles, features and application data of the new high accuracy detector for locating leaks in vacuum and pressure systems now being manufactured by General Electric. It includes discussion of the maintenance features, installation and consultation services, and optional accessories.

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L-1-10—Now available is a 96 page Scherr Tumiso "Precision Measuring Tools and Instruments" Guide and Catalog. This catalog features a complete line of Scheer Measuring Tools and Toolroom Specialties, Optical Measuring Equipment, Gear Hobbing and Gear Testing Machinery as well as Tumico Precision Measuring Instruments.

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L-1-11—A universally applicable guide for the recruiting of engineering college graduates has just been published by the American Society of Engineering Education.

"It is in the best interest of students, colleges, and employers alike that the selection of careers be made in an objective atmosphere and complete understanding of all facts," according to the ASEE guide. The eight-page leaflet lists in detail recommended practices and procedures by employers, colleges, and students to assure that these ends will be achieved.

This is the second revision of the original "code," first published in 1949; the current revision is entitled "Recruiting Practices and Procedures—1959."

W. W. Burton, employment manager of the Minnesota Mining and Manufacturing Company and chairman of the ASEE Committee on Ethics which was responsible for the publication, says, "This is a combination of the best thinking of representatives from both industry and education and represents the highest standards of ethical procedures yet developed. In its preparation industry and education have had equal voices.

Copies may be obtained from ASEE at the University of Illinois, Urbana, for 10 cents each, 25 for $1.00, $3.00 per 100.

section briefs

ALBANY . . . Charles A. Bicking, Carborundum Co., Niagara Falls, N. Y., spoke on "QC in the Chemical Industry," at the meeting Dec. 10. Preceding this talk, Mike Moscinski conducted a tour of the Watervliet Arsenal. After the tour QC methods employed by the arsenal were discussed.

ALBUQUERQUE . . . To stimulate interest in section affairs and in the theory and application of statistical QC, the section is sponsoring and urging section members to enter a paper writing contest on the subjects of constructive criticism of the local and national Society and the theory and specific unique examples of the application of statistical QC. The papers in each category will be separately judged by a special committee and winning papers will be submitted to **Technometrics** or **Industrial Quality Control** as appropriate.

ALLENTOWN-BETHLEHEM . . . On Dec. 9, 1959, at the Hotel Traylor, occurred an event that members and guests will not soon forget! This was the occasion of this section's first Buzz Session. The topic discussed was "How to Sell Quality Control." Our keynote speaker was our own Bonnie Small, who did an exceptional job of setting the stage for the discussions at the various tables which followed her short talk on the subject. Despite the many and varied opinions, one fact seemed universal—that the subject cannot be covered in one evening! We highly recommend the buzz session as a means of spreading the gospel of quality control.

BALTIMORE . . . The December meeting at the Baltimore Memorial Stadium, home of the Baltimore Colts' football team, featured Michael J. O'Callaghan, operations analyst of the British American Oil Co., Toronto, Canada. He gave an enlightened talk to a captive audience on a new application of regression analysis. This application was in the area of budgetary control. Methods and accounting personnel in the audience gained some insight into the possible application of this scientific technique in their plant operations.

Prior to the meeting the third of seven QC basic training sessions was given by D. Taylor, section secretary. He discussed confidence and tolerance limits.

Frank Cullen, section chairman, plans to conduct a meeting on the reliability seminar, a renewed membership drive and a report on running an EVOP course in May 1960. This executive committee meeting is expected to provoke many interesting comments.

BINGHAMTON . . . The section held its Fourth Annual Management Night banquet meeting. The event was preceded by a cocktail party and social hour. Ninety-five members and guests were privileged to hear Leonard Seder, QC Consultant, Malden, Mass., speak on "The Span Plan for Process Capability." The section was honored to have as guests some of the local industries' "top level" managers.

BIRMINGHAM . . . The Birmingham section feels particularly fortunate in having William Golomski as the speaker for the meeting Mar. 18. Mr. Golomski will speak on operations research.

Howard College at Birmingham has scheduled a course in "Engineering Statistics and Quality Control." Professor R. E. Wheeler, head of the department of mathematics and engineering, will be the instructor for the spring semester.

BOSTON . . . Our meeting Dec. 3, had one hitch—too many forgot to give George Mason their reservations, including this reporter, so we were crowded and delayed. The food was worth waiting for, though, and the food-for-thought, served by W. S. Hertzmark, on "Techniques of Product and Process Control," was just what the crowd came for, apparently, from the many questions.

Martin W. Rogers, RCA-Moorestown, N. J., was to be our section chairman this year. Duties of his new position took him away, however, and so it was quite easy for vice chairman W. A. Donovan to convince "Marty" that the least he should do would be to give us a talk as one of the season's speakers.

The section has a committee working on the plan to charter a plane for the crowd planning to attend the annual convention in San Francisco.

BUFFALO . . . A. Putnam, QC director, radio tubes division, Sylvania Electronics, Emporium, Pa., will speak on "QC in the Electronics Industry," at the meeting Mar. 28, at the Red Coach Inn, Niagara Falls, N. Y.

CHARLESTON . . . "Statistical Applications in a Chemical Company," was the topic of a recent talk by Harry Smith, head of the department of mathematics and statistics, Procter and Gamble Co., Cincinnati, Ohio.

This talk was especially suited to the membership of the Charleston section because of the heavy concentration of the chemical industry in the Kanawha Valley. He also discussed some of the problems met in selling statistical ideas to management.

The Charleston section is proceeding with perhaps the most ambitious educational program ever offered by a local section. The first of six courses began this month. The series of six courses will extend through the next two years. Each course, consisting of a 2½ hour class session meeting on ten consecutive Wednesdays, will be offered in duplicate to facilitate scheduling. The six courses are: basic statistical QC, small sample statistics and tests of significance, two variable correlation and regression analysis, analysis of variance and elementary design of experiments, multiple correlation and regression analysis, and advanced design of experiments.

CHICAGO . . . Wednesday, Mar. 16, the section will hold its 6th general meeting at the Furniture Club of America. The afternoon session which begins at 4:30 p.m. (speaker and topic to be announced) will be followed by a social hour and dinner.

We will be honored by a visit from our national president, C. E. Fisher, who will address the group on "Professional Development in ASQC."

The Chicago section extends its invitation to members of our neighboring sections to attend this meeting. We are sure that what our president will have to say about this all-important subject will be of great interest.

Dinner reservations can be made by contacting W. Skawinski, Illinois Testing Lab., Inc., telephone WH 3-1331.

CINCINNATI . . . Robert M. Hofstead, assistant director of statistics, Bristol Laboratories, Syracuse, N. Y., spoke at the technical meeting Dec. 16. His subject was "Application of Statistics in Pharmaceutical Manufacture." Mr. Hofstead presented examples of control of product with $\bar{X}$ and R charts. A comprehensive discussion period followed the formal presentation.

Dick Race, quality manager, U. S. Playing Card Co., discussed the "History of Playing Cards," at the dinner held prior to the technical meeting. Also at the dinner meeting Bill Barker, District 8 representative, discussed some section and district activities.

The symposium Feb. 29, "Statistical Methods in the Chemical Industry," with the American Chemical Society, is expected to attract a good turnout of members and their guests from both Societies. Ralph A. Bradley, chairman, department of statistics, Florida State University, will discuss "Survey the Areas of Application," and Harry Smith Jr., Procter and Gamble Co., and a member of the Cincinnati section, will give "Some Specific Examples."

CLEVELAND . . . Colston Warne, president, Consumers Union, and professor of Economics, Amherst College, spoke on "Quality Assurance for Home Products," at the meeting Dec. 11. A large turn out of members and their wives learned how Consumers Union makes its tests to determine quality, the problems involved in the testing and other interesting side lights on many familiar products.

The fall educational program "graduated" 28 members at the final session Dec. 14. Harry Wadsworth, education chairman, and Jim Oesterling, section chairman, gave diplomas to all who finished the course in "Fundamentals in Quality Control."

COLUMBUS . . . George A. Henderson, chief, reliability branch, research and development division, Army Rocket and Guided Missile Agency, addressed a joint meeting with ASME on reliability engineering at Battelle Memorial Institute Dec. 10. Mr. Henderson presented some practical applications of reliability along with discussing its importance to the National Guided Missile program. The question and answer period developed into an interesting and enlightening 30 minutes on the different aspects of our missile program.

On Dec. 15, the section held a joint meeting with the Institute of Industrial Engineers. Joseph Movshin addressed the group on "Control Charts in Industrial Engineering."

DALLAS-FORT WORTH . . . The plant tour of TEMCO Aircraft Co., Dec. 10, was well attended. The program was interesting and very well planned. Many of the attendees who had previously thought of Temco as a relatively small company were amazed at the size and complexity of the operation. The tour itself was both interesting and informative.

Carl M. Schwalm, senior engineer—reliability, Temco Aircraft Co., will speak to the four Texas sections during the last week in February.

DELAWARE . . . At our "Introduction to Random Balance" session at the Lord de la Warr Hotel, Dec. 3, about 30 members and guests heard Frank Satterthwaite describe the history and philosophy of random balance.

The all day conference at the Rodney Hotel on the following day proved most fruitful to 40 members and guests. We learned the technique of polyvariable experimentation through random balance and random evolutionary operation, REVOP for short. The entire group solved hypothetical problems through the use of these techniques. The group was amazed by their simplicity and seeming effectiveness. There is no question that it is a good tool for screening type experiments.

EVANSVILLE-OWENSBORO . . . The section toured the Green River Steel Corp., plant in Owensboro Dec. 15. The tour proved to be very interesting.

The March meeting will be held Mar. 15, at O'Henry's Restaurant, Owensboro. The speaker will be M. S. Wilson, QC manager, Collins Radio Co., Cedar Rapids, Ia. Mr. Wilson's subject will be "Small Lots and Short Run QC."

GREATER MUSKEGON . . . Our December meeting was a big success, with approximately 50 people in attendance to hear Emery Gotschall, Zenith Radio Corp., speak on quality control functions pertaining to purchased parts at Zenith Radio Corp. Based on the number of questions following his talk, we can say his presentation certainly stirred up a lot of interest. The section would like to thank Anaconda Wire & Cable Co., for their help in bringing the speaker to Muskegon.

HAMILTON . . . The tour of the Firestone Tire and Rubber Co., plant was an unqualified success. We are indebted to the management and those employees who not only made the tour possible, but also made it extremely interesting and instructive.

At our regular meeting Mar. 10, L. Marzec of the Canadian Westinghouse Co., will speak on "Reliability."

HAMILTON-MIDDLETOWN . . . Paul D. Bullock, assistant technologist, U. S. Steel Corp., will discuss "Some Aspects of Evolutionary Operations," at our Mar. 9 meeting. Evolutionary operations as a system contends that industrial processes should be run to generate not only the product, but also generate information as to how the product was made and how it can be improved. Mr. Bullock will introduce us to this new field without dwelling on the esoteric aspects of EVOP. John Bemesderfer, section chairman, will present a coffee talk on "Why Join ASQC?"

James Barrabee, chief QC engineer, Hoover Ball and Bearing Co., gave an interesting talk on "Planning and Quality Engineering—Prerequisites of QC success." In his talk, Mr. Barrabee discussed the initial undertaking of the Hoover Co., in preparing personnel for QC acceptance. Process capability studies were made of each and every machine in the plant. Control charts and report forms used at Hoover were shown and explained.

HARRISBURG . . . Our December meeting was held at the Yorktowne Hotel, York, Pa. It was a panel discussion on "Who Establishes Specification Limits?" Many interesting views were expressed by the purchasing agent, senior design engineer, industrial engineers, chief inspectors and the plant manager on the panel. They discussed such timely topics as machine capabilities, raw material and vendors problems, incentive factors versus market values, management's part in maintaining specifications, and the functional viewpoint of the design to meet all desired properties required. Harmon S. Bayer, Detroit QC consultant, employed at P. H. Gladfelter Co., Spring Grove, acted as moderator.

Our annual Ladies night will be Mar. 2. The program will include a tour through the Lambert-Hudnut plant in Lititz, Pa., conducted by Paul A. Rohif, QC manager and a Harrisburg section member. Dinner and dancing will follow at the General Suttor Hotel.

HARTFORD . . . "Metrology and the Setting Up of a Metrology Department and a Gage Control Program," was the subject presented by J. L. Bolster and W. B. McCallum, QC Advanced Process Control Equipment, Defense Electronics Division, Ordnance Department, General Electric Co., Pittsfield, Mass., at the meeting Dec. 15.

Metrology is the science of measurement. Its foundation, applications and philosophies are vital organs of our business and, indeed, our way of life.

The presentation covered the structure of mechanical standards, the echelons of calibration, accuracy objectives and the control of gages and measuring devices.

HUNTSVILLE . . . Feb. 25, Robert M. Laforge, department of industrial engineering, University of Tennessee, will speak on "Industrial Engineering," at the Elks Club, Huntsville, Pa.

INDIANAPOLIS . . . The Hawaii Visitors Bureau, 2051 Kalakaua Ave., Honolulu, has promised us a new film for the social hour preceding the March meeting. In December, members of the executive committee previewed and approved "Hawaii—the 50th State," to be shown at the January meeting. This followed bookings of "Modern Hawaii," (Coronet), in October and "Treasure Island," (Dole-Hawaiian) in November. We are keeping our promise made to the president when he spoke on the Mid-Pacific Conference at our September meeting. "Gene" made the Hawaii junket seem within the reach of all who heard him.

Mae Goodwin Tarver, secretary of the Chicago section, spent the holiday season with Henry and Marjorie Jacobson at their home in the country.

UNIVERSITY OF IOWA . . . On Friday evening, Feb. 26, at 8 p.m., the section will meet at the John Deere "Little Theater," 3400 River Drive, Moline, Ill. Harmon S. Bayer, QC Consultant, Detroit, Mich., will present, "How to Use $\bar{X}$ and R Charts Effectively."

Thursday and Friday, Mar. 24, 25, the section will meet at the Blackhawk Hotel, Davenport, Ia. After registration we will proceed with a plant tour of the Aluminum Company of America, Riverdale, Ia.

Thursday afternoon a question and answer session will be conducted by Alcoa personnel.

The technical session is scheduled for Friday, Mar. 25, under the direction of J. N. Berrettoni, professor of statistics, Western Reserve University, Cleveland, Ohio. His subject will be "Variable Sampling Plans, Their Efficiency in Controlling Quality."

JOPLIN . . . The December meeting was held Dec. 17 at the Sands Motel Restaurant. Clarence Danie , conservation agent, spoke on "Wild Life Control." Mr. Daniel presented very vividly the part quality control plays in control and preservation of game animals and birds. A very lively question and answer session followed.

KANSAS CITY . . . Fred Cooper, British vice consul in Kansas City, recently presented an interesting and lively talk on "Quality Control in British Industry." In conjunction with his talk, Mr. Cooper presented a quality control film prepared by British Standards Association. The film plot centered around the conversation of four passengers aboard a commercial airplane. Two men from the same plant discussed how their factory was dealing with quality problems. Two other passengers, the manager of another plant and a statistician, became involved in the discussion. The statistician concluded the film by explaining basic principles of quality control.

Two events, a regular meeting and a winter social, will be held by the Kansas City section in February. On Feb. 18, the meeting will feature a gage clinic. Speaker for the evening will be John Theurer, area representative for Boice gages. Mr. Theurer will introduce the latest gages and a round table discussion on the general topic of gages will be conducted. The winter social will be held on Feb. 27, at the Memorial building. An orchestra will provide dance music. At midnight breakfast will be served to members and their guests.

LEXINGTON . . . The section changed its regular meeting to Dec. 4, in order to have a joint meeting with ASTE and the ASTD. A combined meeting attendance of 175 persons enjoyed a fine meal served in the plant cafeteria of the Electric Typewriter Division of IBM, Lexington, Ky. C. G. Schelly, Do ALL Co., presented an excellent slide and lecture session on the "Story of the Cutting Edge." We note that a number of sections have programmed this show. We can assure them that they have an interesting session ahead.

At a recent meeting, Glenn Padgett and Tom Burleson, General Electric Co., presented some visitors from Glass Bulbs Ltd., Harworth Doncaster, England. In rounding up the group's comments, taken from the guests cards turned in after the meeting, they probably will not be able to become members due to the travel time involved.

The course in basic statistics at LaFayette Trade School ended Dec. 15, with 14 men completing the course. The section presented certificates of achievement to the students on this occasion. Instructor was John Sisto, an IBM statistician.

LIMA . . . The section held a special recognition and introduction of new members at its December meeting at the Sylvania Electric Plant, Ottawa, Ohio.

Three of the section members are currently engaged as instructors in the section's educational program. Lloyd Harvey is teaching acceptance sampling. Richard Peggs and Darrell Fultz are teaming up to present intermediate statistical quality control.

The March meeting will be a dinner meeting with Leon Bass visiting the section again as speaker.

LOS ANGELES . . . During December, the Los Angeles section hosted a reception for Si Collier, former ASQC president and recently retired from John-Mansville. More than 50 attendees toasted his past and future efforts for ASQC. Included among the guests were Mr. and Mrs. Harry Romig, Hoffman Electronics, Mr. and Mrs. Ray Crawford, Lockheed Aircraft Corp., Mr. and Mrs. Henry Matosoff, Cannon Electric and section chairman, and Hans Engle, plant manager, Lompoc plant, John-Mansville.

Our December meeting was addressed by J. L. Coburn, Convair, Fort Worth, Tex. His topic was "The B-58 Reliability Program." Mr. Coburn gave a brief history of Convair's efforts in reliability---how reliability was started, where the company is now in their programming and efforts, and their prospects for future reliability efforts on the B-58. He also discussed their vendor's reliability programs and the vital role the vendor's efforts play in the overall reliability of the B-58 aircraft production.

During March, the section through Ray Primmer, president of QRA, Inc., will hold its second annual Valley Workshop for the small contractor.

LOUISVILLE . . . On Dec. 15, our members made a most interesting tour of the Falls City Brewing Plant. The genial host and guide was Robert Pank. During the beer and chip refreshment period he discussed his plant's QC problems with our group.

The section thanks the Falls City Brewing Company for the enjoyable and informative visit with them.

We hope to have a good turn out for the dinner meeting March 14, at Jimmy Lynn's Restaurant. Donald Dunn, QC manager at the Lexington, Ky., IBM plant, will present "Use of Punched Cards in Statistical QC."

METROPOLITAN . . . The section held another successful Conference at Princeton University Dec. 4-5. All of the speakers did an excellent job and were well received by everyone. This Conference was co-sponsored by the American Statistical Association.

On Feb. 26-27, our Metropolitan Conference on Quality Control will be held at the Hotel Statler, New York City.

On Mar. 23, the Metropolitan section will conduct another plant tour and dinner combination. The topic for the meeting at General Motors, Linden, N. J., will be "Quality Control in the Automotive Industry." This is Ladies Night.

MINNESOTA . . . On Feb. 18, the section will present its Ninth Annual All Day Industrial Clinic for Quality Control. There will be a series of lectures and discussions on reliability, another series on quality control, and a third series on inspection.

The reliability series will be presented by Benjamin Epstein of Wayne State and Stanford Universities, who is recognized by everyone in this field.

Speaking on quality control will be Stephen Adams, Wolverine Tube; James Wills, Ford Motor; Larry Albrecht, Minneapolis Honeywell; Riley Chambers, McCulloch Corp.; Juel Enstad, General Mills, James Spears, Remington Rand Univac, and Armond Stoefen, The Toni Co.

Inspection topics will be presented by Lionel Haugen, American Can; Paul Hill, Texas Instruments; E. D. Myers, Chicago Ordnance Depot, and Harold Gulde, Minneapolis Honeywell.

MID-HUDSON . . . The section held a combined meeting with various technical societies in the area instead of its regular monthly meeting Dec. 9. It was held at the Governor Clinton Hotel, Kingston, N. Y., with D. G. Cooper, executive manager, industrial engineering division, IBM, Kingston, as master of ceremonies. Guest speaker was C. Michael O'Grady. He spoke on "Better Design and More Profits through Value Analysis." Mr. Grady is currently management consultant, value services, General Electric Co., Schenectady, N. Y. In his 25 years service with General Electric, he has worked in cost accounting, statistics, analysis, inventories, wage rates, manufacturing engineering and prior to his present position, he was value analyst at the General Electric Fort Wayne Meter Plant.

The subject was a vital one and directly concerned all of those involved in engineering, manufacturing, procurement, finances and management. The use of value analysis techniques in various companies have shown dramatic cost savings and has recently received the active attention of the military, as shown by its recent inclusion into the Armed Services Procurement Regulations.

MILWAUKEE . . . One of the finest meetings the Milwaukee section has ever experienced was held Nov. 12. Dignitaries present included Gene Fischer, ASQC president; Warren Purcell, executive director; J. Y. McClure, Ellis Ott, and Les Eichelberger, national vice presidents; Mason Wescott, chairman, editorial board of **Industrial Quality Control**, and national directors Erv Schoeninger, Bob Berg, and Shaw Goldthwait. Representing the national office, located in Milwaukee, were Bill Youngelaus, administrative secretary; George Foster, **IQC** editor, and Jean Truettner, office manager. A very special guest was Frank Nixon, vice president for quality, Rolls Royce, Ltd., Derbyshire, England. Mr. Nixon is also president of the European Organization for Quality Control.

One hundred members and guests braved a snow storm to hear Gene Fischer give a sparkling introduction of Ellis Ott. Ellis batted 1.000 pinch hitting for Val Feigenbaum, whose plane had taken him back to Indianapolis. The general topic, "Total Quality Control," was well received and a real thought provoker. Prior to the regular meeting, 30 people attended the two training sessions, one on "$\bar{X}$ and R Charts," the other on "Design of Experiments."

The annual Ladies Night meeting was held Dec. 14. A total of 26 members and 31 guests attended the evening's festivities which included cocktails, buffet dinner, barbershop quartet singing, a travelog on the Hawaiian Islands and a very interesting talk by Art Benscoter, A. O. Smith, Kankakee, Ill., on "Quality Control As a Profession." Mr. Benscoter's talk is best summed up by the comment of one of the guests, "Quality control must really have something as a profession if a man who has been in it as long as the speaker can still be so enthusiastic."

The March meeting will consist of a day long, 7th Industrial Clinic. The Clinic will have four concurrent sessions of three periods each. Fields to be covered tentatively include

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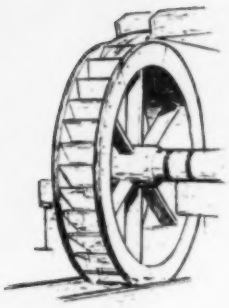

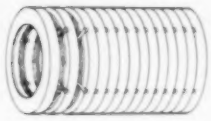

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brewing, electronics, paper and printing, heavy and light machinery and general. It will be held Mar. 18, at the Milwaukee Inn., starting at 9 a. m.

MONTREAL . . . On Dec. 16, D. C. Flischel, General Electric Co., Cincinnati, Ohio, was our speaker. He spoke on "Multi-Level Continuous Sampling." A relatively small group of 17 members and one guest enjoyed a very informative talk and question session.

Mar. 15 a dinner meeting will be held at the Queens Hotel, starting at 6:30 p. m. This will be a joint meeting with C.G.A. The speaker, O. A. Kral, Minnesota Mining and Manufacturing Co., will discuss "Administrative Applications of Statistical QC."

Canadian Pratt and Whitney Aircraft Co., Ltd., will sponsor a plant tour Mar. 30. G. L. Saunders is handling the arrangements for this tour.

At the Dec. 16 meeting of the Ottawa Sub Section of the Montreal section, Bill Wingfield, supervisor of overhaul quality research, Trans Canadian Airlines, spoke on how TCA attempts to forecast downtime and failures by statistical research. He explained how airline maintenance was organized and various data collection methods were used. He showed how last year's operation can be used to forecast next year's requirements. He recommended that every article be serialized and that cost of rectification be maintained.

A tape recording outlining the fears some passengers experience on their first flight set the stage for Mr. Wingfield's talk.

A good attendance is expected at our Mar. 19, One Day Forum, which will open at 9:30 a. m. The forum will feature talks and discussions between service inspection authorities, department of defense production and contractors.

NORTHEASTERN INDIANA . . . The panel meeting Dec. 17, moderated by Ray Snyder, was very well received by the membership. The four panelists—Harold Brenner, Don Hensel, Gideon Statz, and Dick Smith, did an excellent job in presenting each of their companies' quality control programs.

Considerable educational discussion followed the presentations, and it was recommended that additional panel meetings be scheduled.

At the March meeting, the section will be priviledged to hear Stephan J. Adams, Divisional Engineer, Operations Division, Wolverine Tube Co., Inc., Allen Park, Mich. Mr. Adams will speak on "Capability Analysis." The meeting will be 8 p. m., Mar. 17, at the Chamber of Commerce.

NORTHEAST TENNESSEE . . . The section held its ninth general membership meeting Dec. 8, at the Peerless Steak House, Johnson City, Tenn. The first of a series of pre-session meetings was held starting at 6 p. m. The pre-session meetings are on "Acceptance Sampling," and "Statistical Methods for Development and Process Improvement." Each subject will be covered in a four-unit series of lectures during the next four months.

After the pre-session meetings, a steak dinner was served and Richard A. Freund, Eastman Kodak, Rochester, N. Y., gave an interesting presentation on "Acceptance Control Charts." Approximately 60 members and guests attended the meeting.

PARKERSBURG . . . Robert Johnson, chief chemist, Kroger Co., spoke on "Quality Control in the Food Industry," at the meeting Dec. 9 at the Chancellor Hotel, Parkersburg, W. Va. The ladies night meeting attracted approximately 40 members and their guests.

The Parkersburg section has climbed from 73rd to 23rd place in the national Saddoris Award standings. The section has 33 members as renewals, two transfers and one new member at this time.

PENSACOLA-MOBILE . . . One of our own came to the fore at the last section meeting when John W. Comish, section chairman, spoke on "Defect Per Unit Multiple Continuous Sampling." This sampling plan is essentially the same as that outlined in Government Publication AMCM 74-23, "Multi-Level Continuous Sampling Plan," differing only in the definition of a defective. As used in the plan presented, a unit of product containing more than a predetermined number of acceptable defects is non-acceptable.

Mr. Comish is a mechanical engineering graduate of Alabama Polytechnic Institute. While employed as a QC engineer at B. F. Goodrich, Akron, Ohio, he studied statistics and statistical QC at the University of Akron and later taught statistical QC at the Goodrich Institute. Mr. Comish is presently analytical statistician in the MOAMA staff QC office.

The meeting Mar. 22, will feature a plant tour of the Vanity Fair, Clarke Mills, Jackson, Ala. Host will be J. L. Field, QC director, Vanity Fair.

Jules Mehalek presents a door prize to Miss Mary Wolcott at the Philadelphia section Christmas social at the Germantown Cricket Club.

PHILADELPHIA . . . The Christmas social was a huge success with more than 80 persons enjoying the festivities. Mark Sigismund, guest speaker, gave an entertaining talk and slide show of his recent trip to the Antartica on a research project. The balance of the evening featured plain and square dancing, singing of Christmas carols, and the presentation of a variety of beautiful door prizes to all present.

An executive committee meeting was held Dec. 8, at the Germantown Cricket Club, with Jerry Braverman presiding. Items of general interest were: the renomination of W. R. Reeves for 5th district director, ASQC; appointment of G. Nimick as chairman for the symposia operating procedure committee; appointment of J. Mehalek as chairman of the 1959-60 section examining committee, appointment of A. Dettore to represent the Philadelphia section in the Fifth Annual District Conference to be held in York, Pa., and appointment of C. Kniley to represent the Philadelphia section for National Engineers' Week, Feb. 22-28.

Guests are welcome as usual for the meeting Mar. 17. Members and guests should contact Miss Mary Wolcott for reservations, telephone SA 7-1500.

PITTSFIELD . . . M. E. Terry, Bell Telephone Laboratories, spoke on "Design of Experiments," at the meeting Dec. 9. Mr. Terry is qualified in this field due to his active participation in the fields of design of experiments and new processes and procedure controls.

Mr. Terry presented the complex mathematics in simple terms. This considerably enlightened the Pittsfield section toward the overall grasp of the ranges and variability of utilization of this new statistical tool.

He listed four or five major areas covering the basic aspects of the designing of an experiment. These were the determination of the experiment size and complexity; designing the size into two major components—the size of variability and the size of the differences involved in the experiment; the establishing of a schedule of measurements to be performed during the design of an experiment; the analysis of the data as taken during recording stages, and lastly, initiating the various reports which explain the significance of the experiments and the results contained therein.

The meeting excited considerable interest and prompted many questions about this new statistical tool.

PORTLAND . . . A special meeting was held Dec. 8, in the lecture room of the Public Service Building. Our district representative, W. L. Hurd, Jr., reliability operations manager, Lockheed Missile Space Division, spoke on "Management Structure in the Polaris Missile Development." Mr. Hurd explained the functions of quality control, quality assurance and reliability departments.

The meeting Mar. 24, will be sponsored jointly by the ASTE, ASME, ASM and ASQC. The DoALL Company will present "The Story of the Cutting Edge," in the auditorium of the Oregon Museum of Science and Industry.

RHODE ISLAND . . . Members of the executive committee and their wives held a Christmas party in December.

C. E. Noble, manager, consumer marketing research, Kimberly-Clark Corp., will speak on "Operations Research," at the meeting Mar. 17 in the Providence Engineering Building.

RICHMOND . . . Statistically this Indiana section has grown 315 percent over last year. Membership now stands at 104, representing 19 industrial organizations in Richmond, Hagerstown, Cambridge City, Connersville and New Castle, Ind., and (believe it or not) Tucson, Ariz.

The programs so far this year have been outstanding. Speakers have been J. C. Farney, supervisor of physical testing, Aeronica Manufacturing, Middletown, Ohio; Leon Bass, General Electric Co., ASQC junior past president; J. C. Sorenson, manager QC services section, Aeronica Manufacturing; R. N. Johnson, chief chemist, the Kroger Co., Cincinnati, Ohio, and John Gower, attorney from Dayton, Ohio.

Future programs include dinner talks by H. J. Jacobson, QC consultant, Indianapolis, Ind., and J. D. Wills, QC superintendent, Ford Motor Co., Indianapolis, Ind.

The Richmond section is currently conducting a basic statistical QC training course. Thirty members enrolled in the class represent 14 industries in the Richmond area. D. C. Hayward, supervisor quality engineering, Aveo Corp., Richmond, is the instructor.

ROCHESTER . . . It is not too early to remind you of the 16th Annual QC Conference, to be held at the University of Rochester, Wednesday, Apr. 20. Mark this date!

ST. CHARLES . . . James Morrissey, Knowles Electronics, led a discussion during the meeting Dec. 15, on "Control of Opinion in Quality Control." Panel members were George Parsons, Burgess-Norton Mfg. Co., Bob Fischer, General Electric Co., and Ellis Elder, Admiral Corp. They provided practical examples of how opinion was controlled in various stages of their business operations. The meeting was held at the Tally Ho Inn., West Chicago, Ill.

The pre-dinner seminar concerned Military Standard 414. Rick Maus, Admiral Corp., outlined principles of the relatively new sampling plan, pointing out advantages and disadvantages of variables sampling.

This last dinner meeting of the year was very well attended. We believe this was largely due to the efforts of our membership chairman, Al Stolz, Knowles Electronics.

ST. LOUIS . . . The annual Ladies Night will be held Saturday, Feb. 13, at the Golden Fried Chicken Loaf—dinner, dancing, special entertainment.

The Southern Illinois sub-section now has 34 members. They held their Ladies Night meeting at the West Frankfort Country Club recently. Their basic course in statistical QC, taught by Curtis Kurtz, was so successful (31 students) that they are now planning an intermediate course for the near future. Plans are presently being formulated to organize into a full section sometime in the summer.

Presently in gestation is a student chapter of the ASQC at Washington University. This University now requires one semester of engineering statistics for all B. S. candidates in all fields of engineering.

SAN DIEGO . . . The January executive committee meeting was held in the home of Walt Dibblee, USAF.

A. C. McMaster, QC manager, Convair-Pomona, reviewed "Project QC Test Planning," at the December meeting.

The meeting Mar. 14 will be a "sell-out"—so better get your tickets early! William C. Rust, president, Cal-Western University, will deliver an inspiring and informative, as well as an enthusiastic address on "Human Engineering as Applied to Industry." ¡Adios Amigos!

SEATTLE . . . Mel Renquist, chief technologist, Shell Oil Co., Anacortes, Wash., spoke at the meeting Dec. 8, at the Benjamin Franklin Hotel, Seattle, Wash. He discussed QC problems in a petroleum refinery, giving the group a look at automatic controls and the establishment of check points.

SOUTH TEXAS . . . The meeting Feb. 27 will be held at the Houston Engineering and Scientific Society at 7:30 p. m. W. N. Smith, Dow Chemical Corp., will speak on "Response Surfaces." The dinner meeting will be preceded by a training session and social.

SAN ANTONIO . . . During the annual one day symposium, the annual joint meeting of all program chairmen of the Texas sections was held. This is the third year for a meeting of this type. Thus far it has been most successful in that speaker arrangements are made for circuit tours for all the Texas sections for the coming season. Program meetings of this type are encouraged for other sections to sponsor. In fact, most of our previous speakers indicated that their management preferred the circuit tour over the individual basis. It is anticipated that through the joint efforts of the Texas sections another season of top notch speakers will be scheduled for such tours. The San Antonio section wishes all other sections good luck with their tours, and suggests that they investigate the Texas circuit tour system.

The meeting Mar. 22 will be held at 8 p. m. in the Hilton Hotel. J. M. Wiesen, Sandia Corp., Sandia Base, N. M., will discuss, "Reliability vs Quality Control."

SAN FRANCISCO . . . J. Y. McClure, Convair Division, General Dynamics Corp, spoke on "Quality Control's Task in Weapon System Management," at the December meeting in the Nikko Sukijaki Restaurant in San Francisco.

The combination of this excellent speaker, an ASQC vice president and one of the top QC administrators, coupled with a very different and colorful meeting place, resulted in a very fine membership turnout.

The meeting Mar. 8, will be held at Pland's Broadway Restaurant, Oakland, Calif. C. E. Fisher, Bell Telephone Laboratories and ASQC President, will speak on, "Quality Control, a Look Forward."

SYRACUSE . . . There will be no February meeting since the Technical Society Council's Engineering Symposium will be held Feb. 27, at the Yates Hotel. Topics of interest to QC personnel will be included in the program. Inquiries concerning the Symposium should be addressed to Howard McGuire, General Electric Co., Extension 2721.

Frank Caplan Jr., Westinghouse Electric Corp., Blairsville, Pa., will speak on "Quality Control in the Atomic Industry," at the meeting 7 p. m., Mar. 22, at Turn Hall.

TENNESSEE . . . The first in a series of "Something for Everyone," meetings was held at the Oak Terrace, Oak Ridge, Dec. 17. This series of meetings is designed to acquaint persons from all area industries and firms with the role of statistical quality control as the Total Quality Function, as well as to present some of the more technical aspects of statistical QC. At each meeting, two or three short talks present some of the several phases of statistical QC.

At the December meeting, we were honored with three such presentations by section members. William H. Hall spoke on "The Need for Inspection Education in Small Industries," Roberta McCutchen presented "A Simplified Linear Regression Method," and Pete Littleton illustrated "Quality Control in a Hosiery Mill." All members and guests enjoyed the fine lectures. A social and discussion period followed the meeting.

The third such meeting will be held Mar. 10.

TOLEDO . . . The annual Christmas party was held Dec. 12. Originally scheduled for the Secor Hotel, plans were altered when it was learned that the new Engineering Society building was available. The change brought an enthusiastic response. A large portion of the membership brought their wives to help usher in the holiday season with appropriate spirit.

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WHY NOT SEND YOURS IN TODAY?

Charles S. Hicks will speak on "Statistical Aspects of Quality Control," at the meeting Mar. 3. Mr. Hicks is a recognized expert in the analysis of variance. We expect that this meeting will be the highlight of the year's program, as William E. Barker, District 8 representative, will also be present.

WORCESTER . . . Ray Urban, Union Carbide Co., discussed QC in vinyl and polyethylene electrical insulating and jacketing materials at the meeting Dec. 10 at the Worcester Polytechnic Institute. Mr. Urban used slides to supplement his talk and it proved very interesting. The various problems in controlling material quality were discussed as well as some quality techniques employed in producing vinyl sheeting for inflatable equipment. A short discussion period was held following the talk.

On Mar. 17, H. L. Freeman, General Electric Co., New York City, will speak on "Quality Costs." Mr. Freeman has an excellent background for this talk as he is a member of the QC service organization of General Electric. He spends much of his time performing consulting work in the quality cost area within his company. The subject will cover what constitutes quality costs, how to measure them, and how to interpret and use them.

TORONTO . . . At our only meeting in December of last year W. A. Sawyer, Atomic Division, Canadian General Electric Co., Peterborough, did an excellent job on delivering the paper, "Tests for Significance," originally scheduled to be given by Mike O'Callaghan. About 30 members and guests were in attendance and all present thoroughly enjoyed a most interesting and informative evening.

The Toronto section's Seventh Annual All Day Forum will be held at Hart House in the University of Toronto Mar. 5. The format will be as in previous years, that is, several sessions running concurrently throughout the day. The lectures will cover many phases of QC from the basic concepts through operations research in a diversified range of industries and each will be presented by an authority in his or her particular field.

There will also be a basic training course for the benefit of new entrants to this fascinating science. This course will take up the entire day.

The day's proceedings will be brought to a close with a banquet at which the guest speaker will be Ira Needles, president, B. F. Goodrich Rubber Co., Ltd., Kitchener, Ontario.

TULSA . . . R. W. Childress, QC supervisor, Sylvania Electric Products, Inc., Shawnee, Okla., conducted a plant tour and described the manufacture of electron tubes and the quality control operation at Sylvania during the December meeting.

UTICA . . . Dec. 3, an executive committee meeting was held at G. R. Morton's home. During the meeting it was agreed to conduct a QC course; J. Heywood was nominated as candidate for district director from the Utica section, and Leon Bass was nominated for the Shewhart Medal Award.

F. H. Squires, Topp Mfg. Co., Los Angeles, Calif., will discuss the "Management of Reliability Programs," at the meeting Mar. 17, 5 p.m., Hotel Hamilton.

WESTERN MASSACHUSETTS . . . Robert Mitchell, International Latex, spoke to 44 of us at our meeting Dec. 8. He described activities, functions and responsibilities of a QC manager. He placed much emphasis on not only budgeting the QC department's expense but also the necessity for having control of, especially, engineers' time so that a schedule of accomplishments might be met.

The meeting Mar. 8, which is to be a panel type affair involving purchasing and QC, should be very enlightening. This section had a similar panel relative to design several years ago and it was made evident that quality people can make real contributions to problems other than production. It is hoped that similar revelations will come out of this discussion.

YOUNGSTOWN . . . A wonderful evening was had by all. William E. Barker, General Electric Co., Evansdale Division, had the men mumbling in their whiskers while their charming wives conversed. Bill talked on "Are You Sure," and presented a method of checking inspection equipment for accuracy. He used charts governing gage acceptability test and gage repeatability or comparison tests to illustrate his lecture. By use of these control charts engineering can benefit by keeping tolerances within bounds and help to control manufacturing costs. There was considerable discussion after the lecture. We are proud that Bill is our district representative.

Paul Belter, section chairman, presented plans for an educational program. All those interested should contact Carl Hanson, Youngstown Sheet and Tube. Mr. Belter expressed his thanks for the good attendance record and the interest shown at the meetings so far this year. The Society is attracting lots of attention in the Mahoning-Shenango Valley.

SIGNIFICANT DIFFERENCES

. . . Allentown-Bethlehem—With an eye to the future, our section circulated a questionnaire to all members in attendance at the December meeting, inquiring whether any individuals were interested in helping with the administrative duties of the section. It was felt that all members are entitled to the privilege of assisting in this important phase of QC.

Thomas L. Kidd, Autolite, Reading, Pa., recently was married.

Tony Grigas, quality assurance representative, U. S. Signal Corps, has been transferred on a temporary basis from the Allentown plant of Western Electric to the Laureldale plant.

. . . Binghamton—Our congratulations to **Nick Gregrew**, IBM-Owego quality engineering department, who has been promoted to the rank of technical associate engineer.

. . . Boston—**Fred Ryan** has just moved to join the QC staff at the National Co., Inc., in Malden (and Melrose) Mass., as a QC engineer, electrical test section.

Joseph Golden is now with Hermes Electronics, Cambridge, Mass., as QC manager.

Irving Bosinoff was chairman of the Boston Host committee for the PGRQC Reliability Training Conference at the Charterhouse Motor Hotel, Waltham, Mass.

Boston section's education committee is also spreading the word in the EVOP series of lectures at the Hotel Continental, Cambridge, Mass.

. . . Charleston—**C. J. Kennett** has been appointed chairman of the education committee replacing the former chairman, **Charles Drummond**, who was transferred to Wilmington, Del.

T. W. Heiskell has been appointed chairman of the newly formed auditing committee.

. . . Chicago—Attendance at the basic education program sponsored by the section has been gratifying. A visit to one of these sessions by this reporter finds its being well received. Congratulations to **Leo Deja** and his committee.

Howard K. Hughes has been appointed director of the department of physics at the central research and engineering division of the Continental Can Co., Chicago, Ill.

. . . Dallas-Fort Worth—We regret the loss of our section chairman, **Charles L. Scarborough**, who has accepted a position with the Martin Aircraft Co., Denver, Colo. We all wish Charley the best of luck in his new position. **Roger W. Anderson**, current vice president, will serve as acting chairman for the remainder of the fiscal year.

. . . Greater Muskegon—The March meeting is to be held at the Mona Lake Boat Club, where we always enjoy the shrimp dinners. Bill Wiseman, Continental Motors, will present a program about Continental Motors.

. . . Indianapolis—Door prizes at the March meeting will include books and art work depicting Hawaii. The membership drive top prize is James Michener's best seller, **Hawaii.**

. . . Lexington—**Woodrow Waters**, inspection foreman, Lexington Signal Depot, has received a special service award from the Depot Commander for his work on Taiwan last summer. Waters, a civilian, was attached to the Military Advisory and Assistance Group with the Chinese Army for five months to assist with signal supply, maintenance and QC problems.

. . . Lima—**C. Dale Ross** is now foreman in inspection at Ford Motor Co., Lima.

. . . Los Angeles—**I. Paul Sternberg** was recently appointed director, QC, Whittaker Gyro, a division of Telecomputing Corp., Van Nuys, Calif. Paul was formerly staff engineer for the director of reliability and quality, Hughes Aircraft, Culver City.

R. H. Myers, formerly of the staff of the director of reliability and quality, Hughes Aircraft, is now head of a reliability section at Magnovox Research Labs, Santa Monica, Calif.

David A. Hill, formerly director of reliability and quality, Hughes Aircraft, and recently president of the Santa Barbara Research Center (Hughes Subsidiary) is now division manager of the semiconductor division of Hughes Products.

Pat J. Mallon recently replaced **W. R. O'Hara** as the current director of reliability and quality of Hughes Aircraft Co.

. . . Metropolitan—**Al West** has been promoted to special assistant to the chairman of the board of Airtron Inc., a Division of Litton Industries. He will be in charge of Airtron's newly organized quality assurance program, and will be located at the Morris Plains, New Jersey Facility. He was formerly QC manager, Airtron Division, Litton Industries West Coast Facility, Los Angeles, Calif.

. . . Montreal—**R. Vance Ward** spoke at the National Plant Food Producers Association at Washington, D. C., Nov. 6.

. . . Northeast Tennessee—**George Koch**, formerly with Raytheon, Bristol, and more recently from John Oster Corp., Milwaukee, Wis., has transferred his membership from the Milwaukee section back to the Northeast Tennessee section. George is now employed by Monroe Calculating Co., Bristol, Va.

Plans have been made by the Northeast Tennessee section for a joint conference and workshop with the Tennessee section Mar. 17-18, 1960. The conference is open to management and QC personnel and will be held at the University Student Center, University of Tennessee, Knoxville, Tenn. **J. T. Johnston**, QC manager, Raytheon, Bristol, and vice chairman of Northeast Tennessee section, is conference chairman. An extensive program of quality control and reliability will be presented.

Approximately 25 members and local QC personnel completed the nine week course in "Elementary Industrial Statistical Mathematics," at Bristol, Tenn. The course was jointly sponsored by ASQC, city and state educational groups.

Eighty-three members of Raytheon Company's Bristol Plant management completed an eighteen-hour course in "Quality and Efficiency in Action." The instructors in the quality phase of the course were Raytheon employees who are members of the section. **T. E. Alexander**, assistant plant manager, presented certificates of completion at a banquet held in the Raytheon Cafeteria Dec. 28.

. . . Portland—**Ray Vanderzander**, Sawyer's, Inc., has been promoted to staff analyst.

Casey Hoekstra, quality analyst, Omark Industries, Inc., is presently visiting Omark Industries, Ltd., Guelph, Ontario, Canada, to assist the management there in installing a QC program.

Bob MacDonald, Iron Fireman, Electronics Division, will leave his QC work to assume duties as production manager.

. . . Richmond—Section executive committee members for the 1959-60 season are: **B. E. Reynolds**, USAF, chairman; **R. W. Jellison**, Avco Corp., vice chairman and program chairman; **D. A. Rhoda**, Perfect Circle Corp., secretary and treasurer; **D. C. Hayward**, Avco Corp., junior past chairman and education chairman; **H. F. Farmer**, Avco Corp., section affairs chairman, and **F. L. Regnier**, USAF, publicity chairman.

. . . San Diego—**John E. Trader**, supervisor process control, Convair-Astronautics, has been promoted to chief of product quality assurance.

. . . San Francisco—On Dec. 3, the Institute of Food Technology, Northern California section, held its annual meeting. At this meeting, **Stan Hotchner**, American Can Co., spoke on "Acceptance Sampling and its Application to Metal Cans." University of California's **Gordon A. Rowe** spoke on "Developing a Sampling Procedure for Raw Products," and Stokley Van Camp's **C. R. Sheaffer** spoke on "Some Practical Considerations for In-Process Sampling."

Recent promotions are as follows: **E. E. Fuller** to QC manager, American Can Co., (Oakland plant); **Dick Brown** to assistant plant manager, American Can Co., (Oakland plant), and **J. Keate** to QC manager, American Can Co., (Western Division).

Harter Hudson has accepted chairmanship of the 1960 ASQC Convention host committee. He succeeds **Franklin Hunsicker**, who has taken a position as plant manager of the Continental Can Co., Pittsburgh, Calif.

. . . Seattle—Section members have been sorry to hear that our good friend, **Grant Butterbaugh**, has been confined to his home after a long stay in the hospital.

. . . South Texas—The section congratulates and welcomes **R. A. Phillips**, who has recently assumed the position of QC manager, Southwestern Industrial Electronics.

. . . Syracuse—**William W. Soen**, formerly of Easy Washer, has accepted a position at Lipe-Rowway Corp., as manager of manufacturing.

. . . Western Massachusetts—This section has just completed a basic course involving 12 sessions. Sixty-six students started the course with 51 completing it. The course was given in conjunction with the Massachusetts University Extension with certificates being awarded. Of interest was that three ladies were among those who completed the course.

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SECTION CALENDAR (FEBRUARY 25-MARCH 31)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Albuquerque	Mar. 14	University of New Mexico	8:00 p.m.	Reading and judging of contest papers	None
Allentown-Bethlehem	Mar. 9	Hotel Traylor	7:00	European vs. American Standards	Geo. Williams, General Electric Co., Allentown, Pa.
Baltimore	Mar. 15	Baltimore Memorial Stadium	8:15	Binomial Probability Paper	Ervin F. Taylor, The Martin Co., Baltimore, Md.
Binghamton	Mar. 8	Lou's Grill, Johnson City, N.Y.	7:00	Process Controls & Reporting	Cuyler Hawkes, Eastman Kodak Co., Rochester, N.Y.
Birmingham	Mar. 18	———	———	Operations Research	William Golomski, H. J. Mayer & Sons Co., Chicago, Ill.
Buffalo	Mar. 28	Red Coach Inn, Niagara Falls, N.Y.	6:30	QC in the Electronics Industry	A. Putnam, Radio Tubes Division, Sylvania Electronics, Emporium, Pa.
Charleston	Mar. 17	Kanawha Hotel	7:30	QC in the Food Industry	Robert Johnson, Kroger Co., Cincinnati, Ohio
Chicago	Mar. 16	Furniture Club of America	4:30	Professional Development in ASQC	C. E. Fisher, ASQC president
Cincinnati	Feb. 29	Eng. Society Bldg.	7:30	Symposium—Statistical Methods in the Chemical Industry	Ralph A. Bradley, Florida State University
Cleveland	Mar. 16	Eng. Society Bldg.	8:00	Total Quality Control	William J. Masser, General Electric Co., New York
Columbus	Mar. 4	Eng. & Scientific Center	7:45	Non Parametrics	J. E. King, North American Aviation
	Mar. 16	Jeffrey Mfg. Co.	8:00	Evolutionary Operation (EVOP)	Ben Carpenter, Union Carbide and Carbon Corp., Charleston, W. Va.
Dallas-Fort Worth	Feb. 25	Arlington State College, Arlington, Tex.	8:00	QC's Responsibility in a Weapon System Reliability Program	Carl M. Schwalm, Temco Aircraft, Grand Prairie, Tex.
Dayton	Mar. 5	Biltmore Hotel, Dayton, Ohio	9:00 a.m.	Fourth Dayton QC Conference	———
Delaware	Mar. 3	Lord de la Warr Hotel	8:00 p.m.	Sampling and Chemical Analysis of Bulk Material	Acheson J. Duncan, Johns Hopkins University
Evansville-Owensboro	Mar. 15	O'Henry's, Owensboro, Ky.	7:30	Small Lot and Short Run Quality Control	M. S. Wilson, Collins Radio Co., Cedar Rapids, Ia.
Greater Muskegon	Mar. 10	Mona Lake Boat Club	6:30	Continental Motors Program	William Wiseman, Continental Motors
Hamilton	Mar. 10	Westinghouse Auditorium	8:00	Reliability	L. Marzec, Canadian Westinghouse Co., Hamilton, Ont.
Hamilton-Middletown	Mar. 9	———	———	Some Aspects of Evolutionary Operations	Paul D. Bullock, U. S. Steel Corp., Monroeville, Pa.
Harrisburg	Mar. 2	General Sutter Hotel	6:30	Ladies Night Dinner-Dance, Preceded by Plant Tour, Lambert-Hudnut Co., Lititz, Pa.	Paul A. Rohlf, Lambert-Hudnut Co., Lititz, Pa.
Huntsville	Feb. 25	Elks Club	6:30	Industrial Engineering	Robert M. Laforge, University of Tennessee, Knoxville
University of Iowa	Feb. 26	Moline, Ill.	8:00	How to Use $\bar{X}$ & R Charts Effectively	Harmon S. Bayer, QC Consultant, Detroit, Mich.
	Mar. 24	Blackhawk Hotel, Davenport, Ia.	8:00 a.m.	Two Day Session, plant tour, Alcoa, Riverdale, Ia.	———
	Mar. 25	Blackhawk Hotel, Davenport, Ia.	8:00 a.m.	Variable Sampling Plans	J. N. Berrettoni, Western Reserve University, Cleveland, Ohio
Kansas City, Mo.	Feb. 27	Memorial Building	———	Winter Social	———
Lexington	Feb. 25	Lexington Signal Depot	7:00 p.m.	Statistical QC Training in the Ordnance Corps	John F. McAreavey, OMETA, Rock Island Arsenal
	Mar. 17	Lexington Signal Depot	7:00	QC in Europe	Carl D. Larson, General Tire & Rubber Co.
Lima	Mar. 8	Clemans Bldg.	6:30	What Management Expects of QC	Leon Bass, General Electric Co., Cincinnati, Ohio
Los Angeles	Mar. 16	Carolina Pines	6:00	Statistical QC in Glass Manufacture	A. P. Stergion, Corning Glass Works, Corning, N.Y.
Louisville	Mar. 14	Jimmy Lynn's Restaurant	6:30	Use of Punch Cards in Statistical QC	Donald Dunn, IBM, Lexington, Ky.
Metropolitan	Feb. 26-27	Hotel Statler, New York City	———	Metropolitan Conference on QC	———
	Mar. 23	General Motors, Linden, N.J.	6:00	QC in the Automotive Industry—Ladies Night	———
Mid Hudson	Mar. 1	The Anchor Inn, Poughkeepsie, N.Y.	7:00	Statistical QC and Continuously Extended Materials	Frederick C. Hartwell, Peter J. Schweitzer, Inc., Smith Paper Division, Lee, Mass.
Minnesota	Feb. 18	Curtis Hotel, Minneapolis, Minn.	8:00 a.m.	Ninth Annual Industrial Clinic for QC	———
Milwaukee	Mar. 18	Milwaukee Inn	9:00 a.m.	7th Industrial Clinic	Four Concurrent Sessions
Montreal	Mar. 15	Queen's Hotel	6:30 p.m.	Administrative Applications of Statistical QC	O. A. Kral, Minnesota Mining and Manufacturing Co.
	Mar. 30	Canadian Pratt & Whitney	7:45 p.m.	Plant tour	G. O. Saunders, Canadian Pratt & Whitney Co. Ltd., Longueil, Quebec
	Mar. 19	NRC, Ottawa	9:30 a.m.	One Day Forum sponsored by the Ottawa Sub Section	———
Northeast Tennessee	Mar. 17-18	University of Tennessee Student Center, Knoxville, Tenn.	8:00 a.m.	See Tennessee Section	———
Northeastern Indiana	Mar. 17	Chamber of Commerce	8:00 p.m.	Capability Analysis	Stephan J. Adams, Wolverine Tube, Allen Park, Mich.
Omaha-Lincoln	Mar. 11	Western Electric Co., Omaha	7:00	Plant Tour	———
Parkersburg	Feb. 26	Chancellor Hotel	12:00 noon	Calculator and Computor Show and Demonstration	———
	Mar. 16	Chancellor Hotel	7:30 p.m.	Movie: Modern Quality Control	
Pensacola-Mobile	Mar. 22	Vanity Fair, Clarke Mills, Jackson, Ala.	6:30	Plant Tour	J. L. Field, Vanity Fair, Clarke Mills, Jackson, Ala.
Philadelphia	Mar. 17	Germantown Cricket Club	6:15	Delaware Valley—A Great Steel Center	Adolph O. Schaeffer, president, Pencoyd Steel and Forge Corp.
Pittsfield	Mar. 9	Stanley Club, Pittsfield, Mass.	6:45	Operations Research	Albert M. Stover, U. S. Rubber Co.
Portland	Mar. 24	Museum of Science and Industry	7:30	Story of the Cutting Edge, Joint Meeting	DoALL Co.
Rhode Island	Mar. 17	Providence Engineering Bldg.	8:00	Operations Research	C. E. Noble, Kimberly-Clark Corp., Neenah, Wis.

St. Charles	Mar. 15	Tally-Ho Inn, West Chicago, Ill.	7:30	Reliability, A Case Study of a Major Breakthrough in the Electronics Industry	J. Alfred Davies, General Electric Co.
St. Louis	Mar. 18	Golden Fried Chicken Loaf Restaurant	6:00	Machine Capability	Edward Oakley, Delco-Remy Division, Anderson, Ind.
San Antonio	Mar. 22	Hilton Hotel	8:00	Reliability vs. Quality Control	J. M. Wiesen, Sandia Corp., Sandia Base, N.M.
San Diego	Mar. 14	Lafayette Hotel	6:00	Human Engineering as Applied to Industry	William C. Rust, Cal-Western University
San Francisco	Mar. 8	Plands Broadway Restaurant, Oakland, Calif.	7:00	Quality Control, A Look Forward	C. E. Fisher, Bell Telephone Laboratories, New York
South Texas	Feb. 27	Houston Eng. and Scientific Society	7:30	Response Surfaces	W. N. Smith, Dow Chemical Corp.
Syracuse	Mar. 22	Turn Hall	7:00	QC in the Atomic Industry	Frank Caplan, Jr., Westinghouse Electric Corp., Blairsville, Pa.
Toledo	Mar. 3	Lynn's Restaurant	6:30	Statistical Aspects of Inventory Control	Charles S. Hicks, Blairsville, Pa.
Tennessee	Mar. 17-18	University of Tennessee, Knoxville, Tenn.	———	Joint Conference and Workshop with the Northwest Tennessee section	———
Toronto	Mar. 5	University of Toronto, Hart House	———	All Day Forum	———
Utica	Mar. 17	Hotel Hamilton	5:00	Management of Reliability Programs	F. H. Squires, Topp Mfg. Co., Los Angeles, Calif.
Western Massachusetts	Mar. 8	Shelton Hotel, Springfield, Mass.	6:30	Panel: QC and Purchasing	
Youngstown	Mar. 3	Astoria Cafe, Warren, Ohio	6:30	Work Sampling in the Office	William F. Buhl, B.F. Goodrich Co.
Worcester	Mar. 17	Nick's Grill	7:00	Quality Costs	H. L. Freeman, General Electric Co., New York City

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A new service exists for the use of ASQC members only. Any member desiring to be listed as available for new employment opportunities should send a brief resume (on 3 × 5 file card, or cards) to ASQC Personnel Listing Service, Room 6197 Plankinton Building, 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

All information will be kept confidential and those listed will be sent descriptions of all suitable opportunities for 60 days following receipt of this initial listing. If it is your desire to remain on the list after this period, you can do so by writing in to the same address and requesting an additional 60 day period. If you do *not* request an extension, your resume will be removed from the file on the assumption that you have made a successful connection.

Companies wishing to post positions available in the ASQC Personnel Listing Service should address all correspondence to the same address as above giving the educational and experience requirements, age and salary limits on each position. The position description should be limited to 100 words plus the complete name and address of the individual to whom resumes should be sent.

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clinics, conferences, and courses

FEBRUARY

. . . ***18—Ninth Annual All Day Industrial Clinic for Quality Control, Curtis Hotel, Minneapolis, Minn., sponsored by the Minnesota section, ASQC, contact W. E. Parrish, publicity chairman, The Toni Co., A Division of the Gillette Co., Lindeke Bldg., 332 Rosabel St., St. Paul 1, Minn.***

. . . ***24—One Day Reliability Symposium, Statler-Hilton Hotel, Los Angeles, Calif., sponsored by the Los Angeles section ASQC, contact Irving Quart, 12720 Welby Way, North Hollywood; or call ORegon 8-9111, Ext. 1905.***

. . . ***26-27—Metropolitan Conference on QC, Hotel Statler-Hilton, N. Y. City, sponsored by the Metropolitan section, ASQC, contact Edwin Shecter, Sonotone Corp., Box 200, Elmsford, N. Y.***

. . . **27**—Engineering Symposium at the Yates Hotel, Syracuse, N. Y., sponsored by the Technical Society Council, contact Howard McGuire, General Electric Co., telephone Ext. 2721.

. . . ***29—Symposium—Statistical Methods in the Chemical Industry, Engineering Society Bldg., Cincinnati, sponsored by the Cincinnati section, ASQC.***

MARCH

. . . ***5—Fourth Dayton Quality Control Conference, Biltmore Hotel, Dayton, Ohio, sponsored by the Dayton section, contact George A. Friesell, Dayton Air Force Depot (MDQ), Dayton 20, Ohio.***

. . . ***14-18***—32nd Institute on Industrial Relations at the Hollywood Beach Hotel, Hollywood, Fla., sponsored by the National Association of Manufacturers.

. . . ***23-24***—Tenth Annual Iron and Steel Conference at the Pick-Roosevelt Hotel, Pittsburgh, Pa., co-sponsored by the Metals and Ceramics Industry Division and the Pittsburgh section of the Instrument Society of America, contact R. E. Blackwell, Box 1346, Pittsburgh 30, Pa.

APRIL

. . . ***2—Fifth District All Day Conference, Hotel Yorktowne, York, Pa., sponsored by the Harrisburg, Pa., section, ASQC.***

. . . ***3-15***—Sixth Advanced Statistical QC Institute, contact Theodore A. Toedt, University of Connecticut, Storrs, Conn.

. . . ***18-19***—Third Annual Conference on Automatic Techniques, sponsored jointly by ASME, IRE, and AIEE, at the Cleveland-Sheraton Hotel, Cleveland, Ohio, contact the Publicity Chairman, Room 530, 1213 W. 3rd St., Cleveland 13, Ohio

. . . ***20—Sixteenth Annual QC Conference at the University of Rochester, sponsored by the Rochester section, ASQC, contact C. Robert Stumpf, publicity chairman, Eastman Kodak Co., Kodak Park Works, Film Testing Division, Bldg. 6B, Rochester 4, N. Y.***

MAY

. . . ***9-13***—1960 Castings Congress and Exposition, Philadelphia, Pa., sponsored by the American Foundrymen's Society, contact Denham & Co., 925 Book Bldg., Detroit 26, Mich., telephone WO 5-4941.

. . . ***24-26—14th Annual Convention and Exhibition of the American Society for Quality Control, Hotel Sheraton-Palace, San Francisco, Calif.***

. . . ***30-31, June 1—Mid-Pacific Conference, Honolulu.***

JUNE

. . . ***7-17***—Second Annual Short Course on the Design of Experiments, Charles R. Hicks, instructor, and a concurrent Advanced Short Course in Quality Control, Irving W. Burr, instructor, at Purdue University, contact Mr. Hicks or Mr. Burr, Purdue University, Lafayette, Ind.

. . . ***13-24***—Two University of Michigan Engineering Summer Conferences: Models and Simulation in Operations Research, and Foundations and Tools for Operations Research and the Management Sciences, contact R. E. Carroll, Engineering Summer Conferences, University of Michigan, College of Engineering, Ann Arbor, Mich., telephone NOrmandy 3-1511, Ext. 2079.

. . . ***19-25*** and Aug. 7-13—Institute for Practical Research on Operations, contact Theodore A. Toedt, University of Connecticut, Storrs, Conn.

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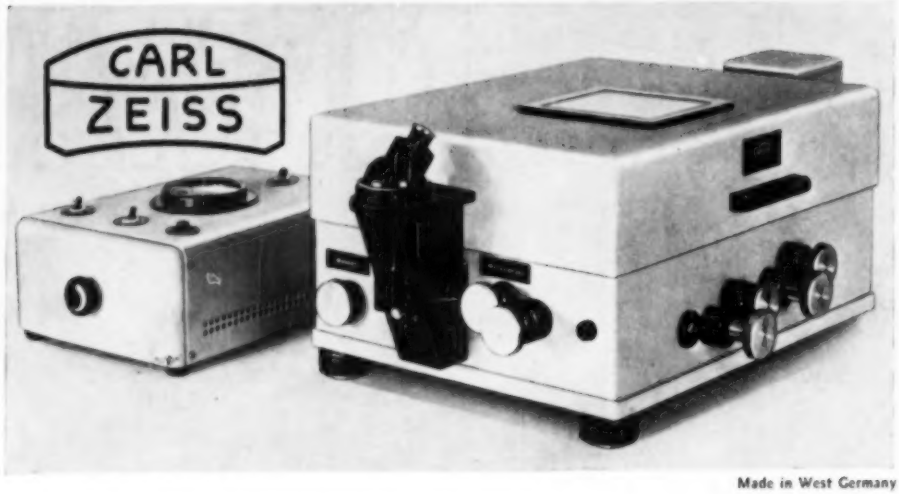

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The absolute length of a gauge block may be determined with this instrument by three methods:

1- By comparing the gauge block with that of a standard block.

2- By a combined measurement of three unknown gauge blocks (three-block measurement).

3- By measurement with wrung-on gauge block.

Measurement of two different gauge blocks is also possible (differential measurement) as well as measurement by comparison of two gauge blocks of equal length. The relative measurement may, moreover, be rechecked by white-light interferences.

All optical components of the instrument are mounted on a sturdy cast-metal base, and are protected by a hinged lid. Housing of the cadmium lamp is attached to the back of the case, opposite oblique eyepiece. Rotating knobs on front operate adjustment of the three wave-lengths and measuring device. Gauge blocks are placed on adjustable tables of instrument and fixed by holders. For measurement with the wrung-on gauge block, the path of rays is deviated by inserting two mirrors while the adjustment is maintained.

Write for booklet which gives complete details.

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COMPLETE SERVICE FACILITIES